COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers

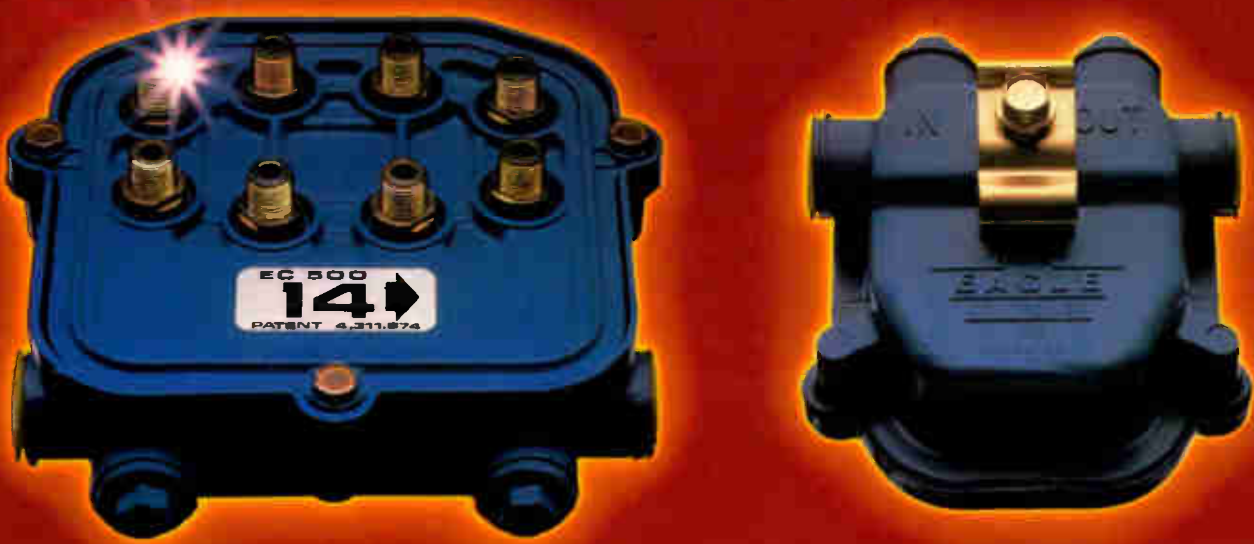
System upgrades: A planned process

Satellite scrambling for security's sake

September 1985

E A G L E

TAPS



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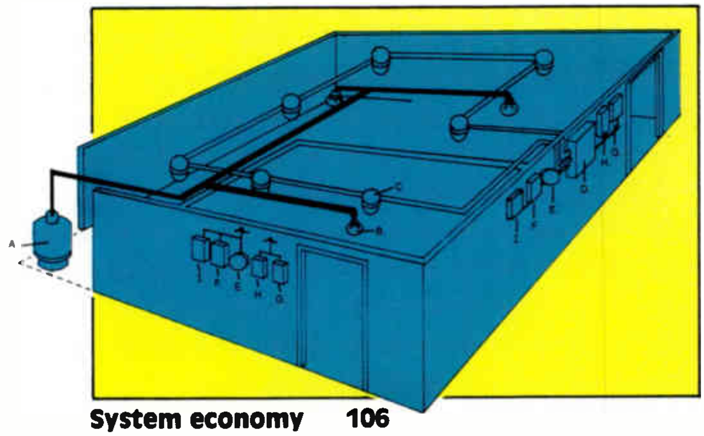
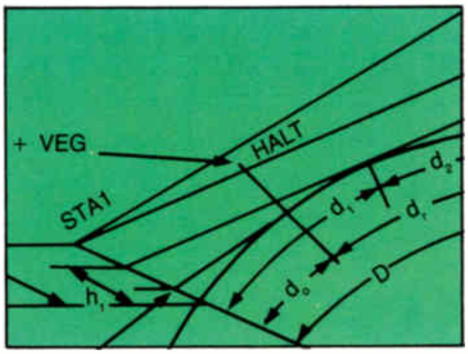
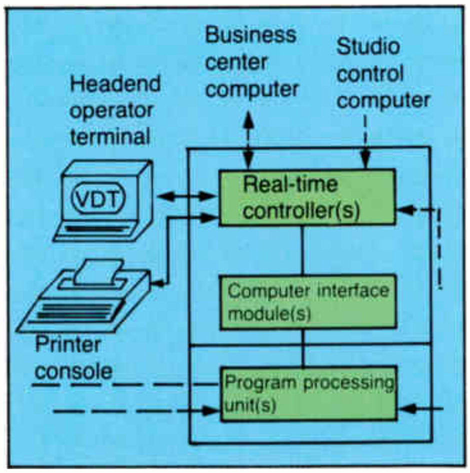
Departments







Features

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Service is not a four-letter word

In the cable industry, like so many other businesses, providing a service is what we thrive on—and profit from. It is not something to be taken lightly. It is something we all have a stake in. Each of us must make a commitment to do the best possible. By doing so, we ensure the prosperity of our industry, our companies and ourselves.

Cable's commitment is to provide the best possible service to its subscribers; to whom we, as an industry, owe a great deal. It is because of the enviable position cable TV is in that the industry finds itself under the eye of scrutiny, beset by criticism.

Cable TV is a very visible entity. Approximately 37 million households think enough of cable to pay for it. And it all comes back to service. Cable TV was not designed to fill every niche, but when more and more "could-be" subscribers (one's passed by cable) opt for alternative services, it's time to find out why. Maybe we should take a moment to thank our competition. After all, their continued pressures have gone a long way to contribute to cable's striving to offer the best, and keeping us from falling prey to complacency.

For you, our readers

A few new services worth mentioning are afoot here in the magazine. The first of the good news is that we recently passed the initial audit of circulation by the U.S. Postal Service, which is necessary to obtain second class mailing privileges. Although our permit is still pending approval from postal authorities in Washington, D.C., you may have already noticed that your copy of *Communications Technology* is arriving earlier. That's what second class is all about: reducing delivery time. Thanks to each one of you for sending in a subscription card.

Our other new service, implemented several issues ago, is the reader response card. We are extremely pleased with the acceptance and use of this service, which actually serves a two-fold purpose. First, it helps you keep abreast of the latest technologies via direct communication with the manufacturers; and second, it shows the manufacturers that our readers support their efforts. By using the reader response card you communicate this directly to *CT*'s advertisers, which in turn provide financial support to us so that we may continue to offer you the best.

Changing of the guard

The *CT* staff and I want to wish David Franklin well and continued success in his new endeavor. Franklin, who was Adelphia Communications' vice president of engineering and Region 6 director for the Society of Cable Television Engineers, is leaving the cable industry to attend a two-year program at the East Tennessee School of Preaching and Missions in Knoxville. He will be missed by all of us in the industry.

Filling Franklin's shoes at the SCTE will be Gary Selwitz, who we welcome aboard and look forward to working with. Selwitz is the assistant chief engineer for Warner Amex Cable Communications in Altoona, Pa., and first vice president of the SCTE Appalachia Mid-Atlantic Chapter.

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Official trade journal of the Society of Cable Television Engineers

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BPA membership applied for November 1984.

The Atlantic Show: The great debate

ATLANTIC CITY, N.J.—The fourth annual Atlantic Cable Show will take place Sept. 18-20, 1985, in the Atlantic City Convention Hall. Sponsored by the cable television associations of Maryland/Delaware, New Jersey, New York and Pennsylvania, the theme of this year's show will be "Cable television the great debate."

The show program actually will begin on Sept. 17, with a golf tournament. Exhibits open on Sept. 18; there are a total of 17 hours allotted for viewing. Exhibit hours are: Sept. 18, 1-7 p.m.; Sept. 19, 10 a.m.-5:30 p.m.; and Sept. 20, 9:30 a.m.-1 p.m.

For those interested in technical sessions only, the Society of Cable Television Engineers, in cooperation with the Atlantic Cable Show, has provided a special one-day registration for SCTE members and their spouses. This special rate entitles SCTE members to all technical sessions on any one of the three days. The entire technical schedule follows.

Technical agenda

Wednesday, Sept. 18, 1985

2-3:30 p.m.—A debate on multichannel sound: A technical nightmare?

Moderator: Bill Riker, executive vice president, Society of Cable Television Engineers. *Panelists:* Alex Best, manager of research and new business development, Scientific-Atlanta; Ned Mountain, director of marketing, Wegener Communications; Tom Matty, vice president of engineering, W&S Systems Co.; and George Green, international product manager, Zenith Electronics Corp.

4-5:30 p.m.—A debate on theft of services. Is the solution in the office or in the field?

Moderator: Al Kuloas, vice president of operations, American Cable Systems. *Panelists:* Frederick Cluthe, director of data processing, Suburban Cablevision; and Robert Tenton, vice president of engineering, Manhatten Cable TV.

Thursday, Sept. 19

10-11:30 a.m.—A debate on the cost of technology. How much technology can we afford?

Moderator: John Kurpinski, turnkey sales manager, Cable Services Co. Inc. *Panelists:* Richard McCaffery, group vice president, James Murphy, controller, and Frank Ragone, vice president of engineering, Comcast Corp.

1:30-3 p.m.—A debate on signal leakage. FCC specifications, update on latest technical rules, required tests and how and when to perform them.

Moderator: Clifford Paul, consulting engineer, RT/Katek Communications Group. *Panelists:* John Wong, chief engineer, Policy Branch, FCC Mass Media Bureau; Robert Luff, senior vice president of engineering, United Artists Cablesystems Corp.; Fred Gaska, area technology manager, Storer Cable Communications; and Robert Dickinson, division manager, Network Technologies, a division of AM Cable Inc.

Friday, Sept. 20

10 a.m.-12 noon—Open forum. Repeat of last year's SRO session. Practical answers to your technical questions by hands-on experts.

Moderator: Thomas Gimbel, staff engineer, Comcast Corp. *Panelists:* Mark Dzuban, vice president of engineering, Cross Country Cable; Alan Hahn, president, Hickory Mountain Associates; Michael Nelson, vice president of field operations, Media General Cable; John Nichols, vice president of engineering, Cablevision Industries; and James Stilwell, president, Tele-Services R&D.

Call for papers for Cable-Tec Expo '86

WEST CHESTER, Pa.—In preparation for the Society of Cable Television Engineers' upcoming Cable-Tec Expo '86, to be held June 12-15, in Phoenix, Ariz., a call for papers and/or proposals for programs and workshops has been issued. The SCTE is calling upon the technical community to submit proposals for formal engineering papers to be presented at the 1986 Spring Engineering Conference. These papers also will be included in the official conference publication.

Likewise, the society is soliciting proposals for hands-on workshop programs to be presented during the Expo itself.

To obtain more information on Cable-Tec Expo '86, circle #1 on the reader service card. Proposals for papers and workshops should be directed to: Bill Riker, SCTE, P.O. Box 2389, West Chester, Pa. 19380, (215) 363-6888.

Pioneer opens offices and receives orders

COLUMBUS, Ohio—Pioneer Communications of America Inc. announced the opening of two regional offices, one in St. Louis and the other in Schenectady, N.Y.

The midwest regional office will service customers in North Dakota, South Dakota, Kansas, Oklahoma, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana and Ohio. The office is located at: 7351 Burrwood Dr., St. Louis, Mo. 63121, (314) 421-4333.

The northeast regional office will service Maine, Vermont, New Hampshire, Connecticut, Massachusetts, Rhode Island, New York, Pennsylvania, Maryland, Delaware, West Virginia, Virginia and the D.C. area. The new address is: 2318 Campbell Ave., Schenectady, N.Y. 12306, (518) 393-6707.

In addition, Pioneer has announced the sale of its BA-5000 addressable converters to Warner Amex Cable Corp.'s Akron, Ohio, system. The order represents a potential 60,000 units over the next two to three years. Warner Amex will be purchasing Pioneer's Dec-based M3 controller, which is capable of managing 200,000 subscribers.

The Akron system, which passes 146,000 homes, is currently using Pioneer's BC-1000 and BC-2000 block converters.

The BA-5000, which was recently upgraded to operate at 550 MHz, is Pioneer's newest addition to its addressable line. The converter has an integrated scrambling method called VCS scrambling, which is compatible with Oak, Jerrold and Hamlin scrambling. The BA-5000 also is designed to accept Pioneer add-ons such as the Pulse adaptor.

Texas mounts anti-theft campaign

AUSTIN, Texas—The Texas Cable Television Association is launching a statewide public awareness campaign to inform Texans that if they are receiving cable TV programming they aren't paying for, the show's over.

One out of every eight persons in Texas receiving cable TV service is receiving some level of service without paying for it. It is estimated that the loss of revenue is in excess of $50 million annually in the state. And the loss in sales tax revenue to the state is estimated to be $5 million per year.

The Texas Legislature passed a new law that goes into effect this month. This law increases the penalty to a Class B misdemeanor, which provides for up to six months in jail and $1,000 fine for stealing cable programming.

New SCTE group

VAN NUYS, Calif.—The Society of Cable Television Engineers Southern California Meeting Group has been formed to provide technical training to the cable television community. It intends to hold meetings bi-monthly on current and informative topics. Its first meeting will be held on Oct. 9 in Torrence, Calif., and the guest speaker will be Jon Ridley of General Instrument. Other meetings are tentatively planned on the following subjects: preventative maintenance; a tour of Hughes space and communications satellite construction bay; multichannel sound; satellite scrambling methods; and a tour of Century III's plant. (See *The Interval* for more information.

SCTE signal leakage seminar

DENVER—The Society of Cable Television Engineers and its Rocky Mountain Meeting Group are co-sponsoring a technical seminar on "Signal Leakage—CLI and the FCC" at the Regency Hotel here on Sept. 10-11, 1985. The schedule of events is as follows:

Tuesday, Sept. 10
8-9:15 a.m.—Registration. Opening remarks—Sally Kinsman, Kinsman Design, SCTE Western vice president
9:15-9:45 a.m.—A history of the signal leakage issue—Cliff Paul, consultant, RT/Katek
9:45-10 a.m.—Break
10 - noon—Live teleconference—Al Kernes, Jones Intercable, moderator (in Denver)
12-1:30 p.m.—Luncheon speaker to be announced
1:30-2:45 p.m.—NCTA Engineering Committee action—Bob Dickinson, AM/Network Technologies
2:45-3 p.m.—Break
3-4:15 p.m.—CLI measurements—Robert Luff, United Artists Cablesystems
4:15-5 p.m.—Proper procedures for filing comments with the FCC—William Riker, SCTE executive vice president
5-7 p.m.—Speaker's reception

Wednesday, Sept. 11
8:30-9:30 a.m.—Registration. SCTE update—Bill Riker, SCTE executive vice president
9:30-10:15 a.m.—Effects of connectors on signal leakage—Bill Down, Gilbert Engineering
10:15-10:30 a.m.—Break
10:30-11:15 a.m.—Selecting the right test equipment—Richard Shimp, ComSonics
11:15-noon—What to expect from an FCC inspection—Dennis Carlton, FCC
12-1:30 p.m.—Lunch with speaker to be announced
1:30-2:30 p.m.—How to organize a leakage program in your system—Pete Smith, Rifkin & Associates
2:30-2:45 p.m.—Break
2:45-3:45 p.m.—Channelization—Sruki Switzer, Cablecasting Ltd.
3:45-4:45 p.m.—Roundtable discussion of signal leakage
4:45-5 p.m.—Closing remarks—Bruce Catter, SCTE Rocky Mountain Meeting Group president

Satellite transponder time for the live teleconference donated by Showtime/The Movie Channel; downlink donated by Microdyne/Dynavision.

Theft workshops in Pa.

HARRISBURG, Pa.—The prosecutor of the so-called "HBO Kid," former Pennsylvania Deputy Attorney General William Arbuckle III, was the main presentor in a series of five anti-theft of cable service workshops held throughout Pennsylvania for cable system operators and law enforcement officials. The workshops were sponsored by the Pennsylvania Cable Television Association and partially underwritten by HBO and Prism.

In "operator-only" morning sessions, Arbuckle told operators how to proceed with civil and criminal prosecutions under state and federal laws. The PCTA members then heard of successful, on-going anti-theft programs in Pennsylvania systems.

The presentation in the afternoon sessions for local law enforcement officials and district justices focused primarily on the changes in Pennsylvania's anti-theft of service law. Following a brief description of how a cable system operates and how theft occurs, Arbuckle told them of the evidentiary requirements under the new law and what to expect from cable operators prosecuting under the state law.

Fiber-optic lifts

EMMETSBURG, Iowa—Durnell engineering has announced that it will begin offering fiber optics as a control option on its line of aerial personnel lifts. The replacement of several hydraulic lines with a single glass cable reduces weight and maintains dielectric integrity. Fiber-optic controls will be displayed at the ICUEE show, Oct. 1-3 in Kansas City, Kan.

Drake positions itself for merger, acquisition

MIAMISBURG, Ohio—The Drake family has announced that it will make the R.L. Drake Co., available for a merger or acquisition. The privately held firm manufactures a line of home earth station receivers and other satellite TV equipment. All Drake equipment is produced and assembled in Franklin, Ohio.

Manhattan Venture Co. Inc., an investment banking firm headquartered in New York City, has been engaged by the company as its financial advisor.

TOCOM receives orders

DALLAS—The TOCOM division of General Instrument Corp. announced that it has received contracts valued at more than $3 million to provide TOCOM Plus addressable equipment to The Lenfest Group of Abington, Pa., and Cable Co. of Claremore Inc. in Claremore, Okla.

TOCOM will deliver 15,000 Model 5503 baseband converters with remote control and 18,000 Model 5501 baseband decoders to Lenfest. Lenfest, which owns and operates 11 cable systems in Pennsylvania, will install initial TOCOM units in Sellersville, Pa., and will introduce new programming services in the 14,000-subscriber system. Sellersville is the site of a recent field trial in which TOCOM equipment is being used to evaluate addressability. Plans also call for pay-per-view services to be introduced in late 1986 when all Lenfest systems are interconnected by microwave, according to the firm. Installation is scheduled to be completed by May 1.

Cable Co. of Claremore will take immediate delivery of 3,000 Model 5503 baseband converters for installation in its 2,500-subscriber system. The system, which passes 5,000 homes, is currently upgrading to 36 channels.

Great Lakes Cable Expo

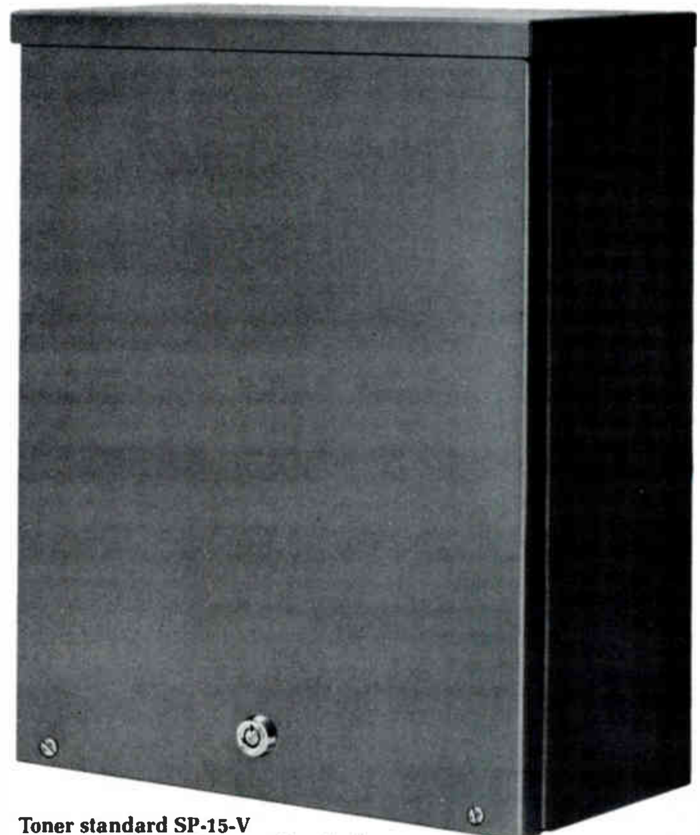
INDIANAPOLIS—This fourth annual Great Lakes Cable TV Expo should provide a good forum for discussion and learning. Featuring over 30 roundtables, the Expo will take place on Sept. 25-27, 1985, at the Indianapolis Convention Center. It is sponsored by the cable television associations of Illinois, Indiana, Ohio and Michigan. Here is the tentative schedule of events.

Wednesday, Sept. 25
11 a.m.-8 p.m.—Registration
1-4:30 p.m.—Society of Cable Television Engineers hands-on workshop
1-2 p.m.—Cable Television Advertising Bureau presentation on the dynamics of local cable advertising
2:15-3:30 p.m.—CTAM managment workshop, profit/loss management
3:45-5 p.m.—CTAM marketing workshop, improving training programs
4:30-5:30 p.m.—Women in Cable reception
5-7 p.m.—Grand opening of exhibit hall, cocktail reception
7:30-9 p.m.—Buffet dinner
9-11 p.m.—HBO presents a Rock 'N' Roll Extravaganza

Thursday, Sept. 26
8 a.m.-7 p.m.—Registration
8:30-9:30 a.m.—Continental breakfast
9:30-10 a.m.—Keynote address, Ed Allen, chairman, NCTA
10 a.m.-noon—Exhibit hall open
Noon-1:30 p.m.—Luncheon
1:30-3:45 p.m.—Technical and marketing roundtables
4-5 p.m.—Washington update
4-5 p.m.—Local programming seminar
4-7 p.m.—Exhibit hall open, cocktail reception
7-9 p.m.—The Expo banquet
9-11 p.m.—Showtime/The Movie Channel presents Ray Stevens

Friday, Sept. 27
8-11 a.m.—Registration
8-9 a.m.—Continental breakfast
8-9 a.m.—State association meetings
9-10:30 a.m.—CEO panel with industry leaders
10:30 a.m.-12:30 p.m.—Exhibit hall open

Hard-to-find lockable cabinets are easy to get here. Even in quantity.



Toner standard SP-15-V cabinet with vending machine lock.

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We have a good selection in stock.

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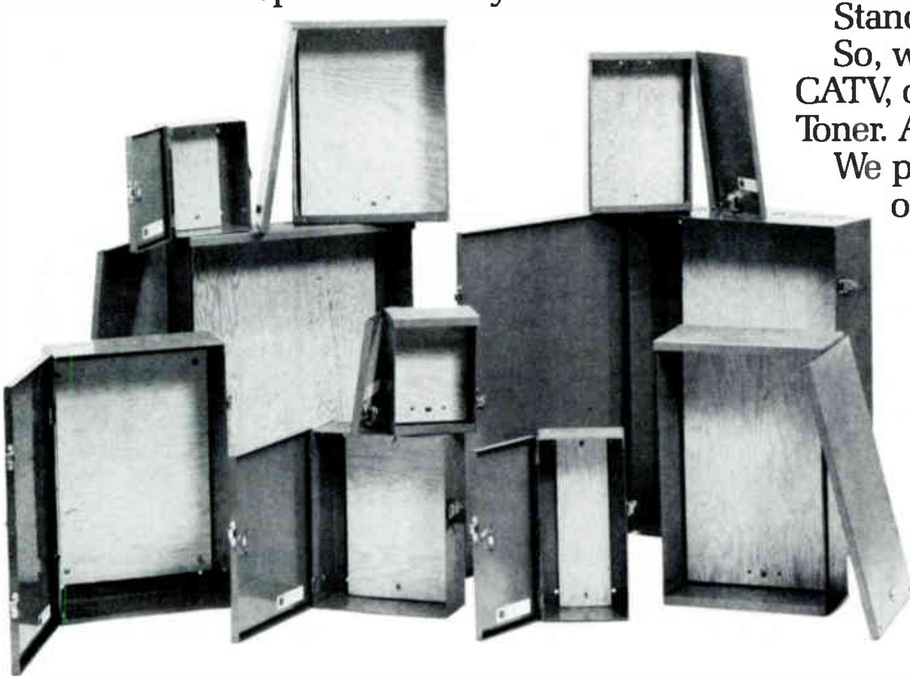
And, for your tough, theft-prone locations, we recommend our SUPER-SECURE™ cabinets. They have flush doors that can't be pried open, fitted with two vending machine locks with non-reproducible keys.



Here's one of our best sellers: The SP-15-V—15″ x 12″ x 6″ shown with vending machine lock.

Has a 3/8″ plywood backboard, as all Toner cabinets do.

Standard finish is satin gray enamel.

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- 71+ CHANNELS
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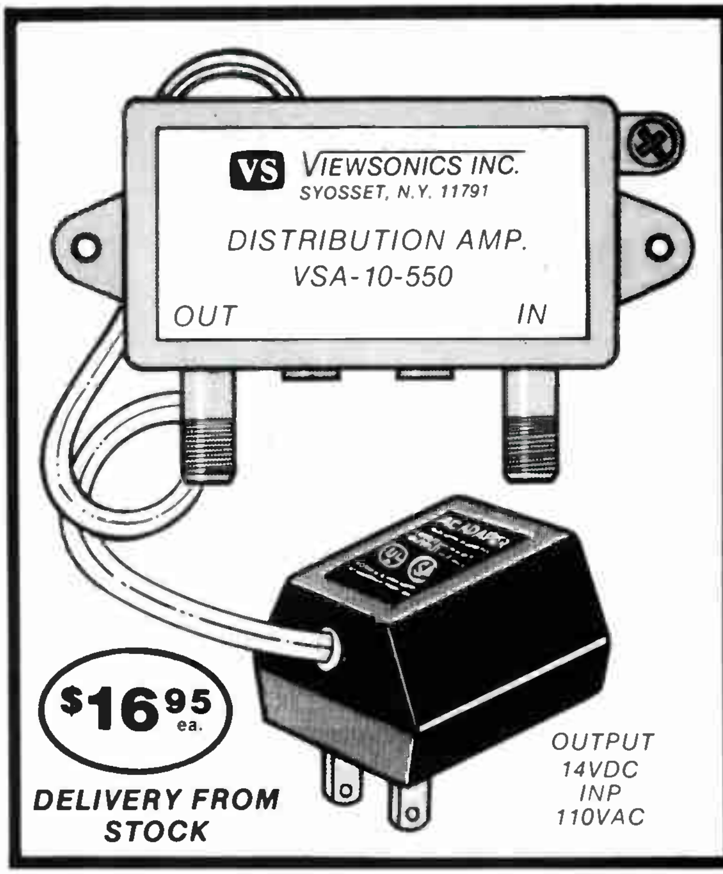
- HIGH CTB.



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SPECIFICATIONS
(50-550 MHz)

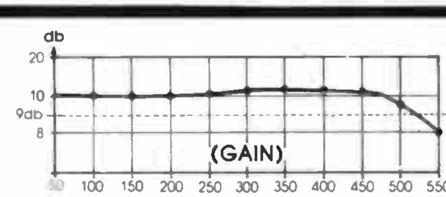
Input Match 14db
Output Match 14db
Noise Figure 10db

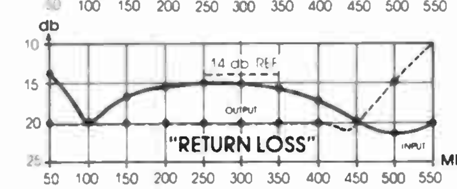
71 Channel CTB @ +20 DBMV out .... -65db
(Composite Triple Beat)

2nd Order Distortion @ +20 DBMV .... -70db

71 Channel X Modulation .... -70db

Typical Inp. Level 10 dB—Maximum 20 dB





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MODEL **VSA-10-5502W**	10db GAIN 2 WAY CAPABILITY	**$24.50** ea.
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Jones uses Magnavox equipment

MANLIUS, N.Y.—Jones Intercable has purchased Magnavox's power doubling and feedforward equipment for two of its systems. In Janesville, Wis., Jones will upgrade its 240-mile system to 400 MHz by using feedforward trunk amplifiers, and power doubling bridgers and line extenders. The company's Anne Arundal, Md., extension will include feedforward trunk amplifiers and power doubling bridgers. Jones has also used this equipment in both its recently upgraded Myrtle Creek, Ore., system and in its Suffolk, Va., new-build.

WAVE goes with Hughes

TORRANCE, Calif.—An order for more than $1 million has been placed with Hughes Aircraft Co.'s microwave products division by Warner Amex Cable Communications. The order calls for a Hughes AML multichannel local signal distribution system, including the AML-STX-141 high-power transmitter, plus receive site and upstream equipment to be installed at the Warner Amex Video Entertainment cable system in Milwaukee. The system is the latest of several Warner Amex major market systems to use the Hughes AML equipment.

The system initially will provide TV programming to three hub sites where the microwave signals are downconverted back to VHF using low-noise 450 MHz phase-locked receivers. Each hub site will include solid-state upstream transmitters to transmit video signals and addressability data back to the master headend.

A Hughes Model OLE-III microwave line extender may be utilized at first to expedite signal delivery during plant construction. Later, the microwave line extender will be used as a "hot" standby to back up premium channels at the master headend site. Automatic receiver redundancy will be used at the hub sites to provide a backup in the event of receiver failure.

Microdyne awards leading distributor

EAST FARMINGDALE, N.Y.—Microdyne Corp. recently presented Tele-Wire Supply Corp. with an award for being Microdyne's largest distributor of satellite CATV electronics in the continental United States for 1984.

Tele-Wire's Satellite and Electronics Division was formed in October 1983, when Martin Ingram joined the company as division general manager. Ingram initiated the Microdyne distributorship shortly thereafter.

Brad Cable's new division

SCHENECTADY, N.Y.—Brad Cable Electronics Inc. has officially opened its Converter Parts Department by promoting John Carmichael to division manager.

In preparation for the grand opening, Brad Cable had increased its converter parts inventory to $1.5 million.

Cablevision Systems goes with CableData

SACRAMENTO, Calif.—Cablevision Systems of Long Island, N.Y., and CableData announced an agreement in which CableData will provide its data processing services for Cablevision's subscribers in 11 systems, serving nearly 600,000 subscribers.

Five data centers will be equipped with CableData's on-line system. Long Island, New York City, Boston, Chicago, and Norwalk, Conn., will be the focal points of subscriber billing activity.

Allied awarded LAN build

NORCROSS, Ga.—Allied Data Communications Group Inc. will perform the design, engineering and installation of the local area network for the University of California at San Diego. The network will handle multi-mode data, video and voice communications for 152 buildings and approximately 6,000 users. One unique aspect of the network is that it is completely underground. The distribution routing follows the underground campuswide tunnel system.

Poleline merged into RMS

BRONX, N.Y.—RMS Electronics Inc. announced the merging of its Poleline Corp. operation with the CATV Division of RMS. RMS will continue to sell some of the more popular Poleline items, such as hardware, pedestals, apartment boxes and traps.

Building a better mousetrap

By David C. McCourt
President and CEO, McCourt Communications Inc.

Although some industry analysts lament the "there's no tomorrow" fate of cable television—describing ills from financial stagnation to market atrophy—our industry, in fact, stands now at the threshold of its greatest challenge and opportunity since invention of solid-state circuitry. True, CATV is ailing. But those are growing pains, not terminal diseases. Soaring construction costs, waning investor confidence, credibility tarnished by broken franchise promises, and mounting municipal and public criticism have halted expansion in some cases, and forced major retrenchments in others.

The current convolutions are normal for any boom industry reaching maturity. There always comes the moment of truth, and now is our time. The laws of survival are weeding out the incompetents, frauds and fly-by-nights, leaving the professionally and morally fit. This is healthy. It is the checks and balances, the very heartbeat, of free enterprise.

But those reputable survivors, the designers, engineers and contractors who built or are building the majority of the CATV systems, face diminishing prospects by virtue of their accomplishments to date. They've already wired much of the nation, with the remainder in planning or underway.

The next step

After you've cabled America what do you do for an encore? Simple. You do it again. Despite the pessimists who see our waterglass of opportunity as half-empty and draining, in my opinion it's half-full and soon to overflow. In fact, we are staring at a multi-billion dollar market that's perfectly suited to our technology and expertise.

We define that market as private communications systems (PCS), also known as local or global area networks and as bypasses, since they bypass telephone company services partially or totally. At their simplest, they're data links connecting computers in or between buildings. But they can be long distance, even global, involving microwave stations and satellites, transmitting voice and video as well as other data forms.

Whatever they're named and however they're sliced, they are communications systems, pure and simple, with installation requiring essentially the same skills and techniques as CATV. We recently built the first underground PCS in Boston and from a design and construction point of view, it's not much different than the cable television system we're building in Sacramento, Calif.

If you think a PCS here and there doesn't exactly add up to a business bonanza, consider the magnitude of the potential market. It includes the 6,272,808 businesses in the United States, 6,953 hospitals, 49,014 financial institutions, 3,280 colleges and thousands more prospects in numerous categories. Collectively they represent what industry analysts see as the blueprint for our future.

Technically, legally and economically, the PCS is indeed an idea whose time has come. For a one-time investment, they free their owners from the mercy of telephone companies, enabling them to decrease communications costs dramatically while increasing capacity, integrity and security. They're kiddingly called BYOB—build your own Bell—but are such a serious threat to telephone systems that those companies project revenue losses in excess of $14 billion annually to PCS by the mid-

'Technically, legally and economically, the (private communications system) is indeed an idea whose time has come'

1990s. Already about 35 percent of their revenues, some $810 million a month, is vulnerable, according to their own studies.

More to offer

Capacity and integrity of private communications systems are as significant as the cost savings. Standard telephone services transmit from 1,200 to 9,600 bits per second, with accuracy deteriorating at higher rates, while a PCS can handle millions of bits per second using broadband RF on coaxial cable—and far higher still with fiber optics that transmit at the speed of light.

Back in the 1800s, a noted gentleman named Ralph Waldo Emerson penned the classic wisdom: "If a man write a better book, preach a better sermon, or make a better mousetrap than his neighbor, tho' he build his house in the woods, the world will make a beaten path to his door."

Our industry now has a better mousetrap called the private communications system. Analysis indicates a vast market ready and waiting to be tapped. But will the world beat a path to our doors? Yes. The rush has already started. It's so heavy that Boston, as one example, has had to declare a six-month moratorium on underground cabling in order to prepare for the oncoming PCS stampede.

So let the gloomsayers wallow in their own defeatism. The rest of us have work to do. We've got a big, robust nation to wire with private communications systems.

Engineering management—No is yes

By Isaac Blonder
Chairman, Blonder-Tongue Laboratories Inc.

Most of the publications on engineering management, in my opinion, are deficient in hands-on experience and tight budgets. Forty-seven years in electronics with never a fat budget inspired this editorial.

My first employment as an electronics engineer was in 1938 as the only degreed person in a radio manufacturing firm producing $6 table radios from 100 percent rejected parts. Then on to the General Electric Radio factory in Bridgeport, Conn., four years as a radar officer in the Signal Corps, various positions in instrument and TV firms, and, finally, to my own company in 1950, Blonder-Tongue Labs. My industry background also includes 30 years continuous attendance on FCC and industry committees, as well as several hours daily reading in new technologies.

I shall comment on engineering project management in two parts—the theory and the practice.

Theory

There are innumerable routine versions, this is one more.

I) Describe the objective clearly and precisely.

II) Communicate with and gain approval of the project from every involved segment of the company.

III) Collect competitive literature and prices.

IV) Locate all pertinent technical publications and compile a representative sample for the engineers' personal libraries.

V) Select a team of engineers and technicians able to accomplish the task.

VI) Require that the parameters of the product follow the theoretical analysis.

VII) Set a budget and a timetable.

Practice

I) Depends on whether you are imitating the competition or creating a new product. It's easy to be precise when there is no creativity, but just try to create an unambiguous proposal clear to all participants when only the inventor has the answers.

II) Selling the project to all levels of management is like trying to give a useful lecture on radar theory to a class composed of high school dropouts, liberal arts students and one engineer. (That's the Army, Mr. Jones!) The description must be limited to words of one syllable, yet accurate enough to define the product precisely for the engineer.

III) All too often the need for a new gizmo is trumpeted by marketing, which just discovered that the competition has it on the market and it is slaughtering sales. Why is it that salesmen are deaf to the consumer complaints and open their ears only when their commission checks get smaller? Also, when the competitive literature and products finally arrive at the home office, we discover that the boogeyman is full of sound and fury but not the absolute menace so chillingly charted by the field men. The engineer soon learns to discount the marketing report, particularly the pricing data, in which their economy items are compared to his designs, incorporating features absent in the targeted competition.

IV) Now, about the library. Words are puny tools to describe the chaos inherent in library management! We may as well pass over this perennial gap in technology transfer, and praise the superb efforts of the technical magazines whose articles are the primary source of current industry know-how for both the experienced and inexperienced design engineers.

V) In the theatrical world, the call for performers is precise and demanding: "Nubile, blonde ingenué with southern accent to play Daisy Mae"; "All American virile juvenile male for the part of young Jack Armstrong"; etc. For each play, the producer will see countless numbers of unemployed applicants bursting with energy and ambition for their place in the sun. The engineering manager, however, must survey his budget-limited cast of characters and try to fit the new project to the available players. You've heard the old story: To produce a new design, one needs 5 percent inspiration and 95 percent perspiration. The project team must possess all the ingredients in proper proportion to the task, a rare occurrence in the average laboratory, and the consequential learning curve renders moot the time and cost budgets! But we press ever onwards, game to the core!

VI) When an engineer leaves school, he usually leaves behind his math and much of his theory. The commercial world wants a saleable product, not a masters thesis, thus designs are not evaluated theoretically. As an example, most of the antennas sold in the United States do not have statistics comparing the calculated patterns with the test range measurements. In any case, few antenna companies even have accurate measuring facilities, and cannot compare the range figures with the theoretical. It must weigh heavily on the conscience of the engineering manager, when he approves the work of his project group, unchecked by a paper study of vital parameters such as gain, bandwidth, distortion, noise figure, temperature stability, MTBF for RF products; and switching speed, error rate, protection scheme, power consumption for digital products.

'The engineering manager is usually alone in his task, facing dissention from every quarter, and principally dependent upon intuition for decisions that could wreck his career'

VII) There are several approaches to a budget and the accompanying timetable. One is to demand strict adherence to the original schedule and correct the problems on the production line or in the field. This occurs in a company dominated by the marketing and financial executives. The opposite approach is to wait patiently until the product is perfect, no matter what the cost and the delay, and preserve the company's quality image.

But the most appropriate tactic is when the engineering manager injects a strategic *NO* into the decision stream. Examples are: marketing demands performance beyond the current state of the art; marketing wants the price reduced below a safe product quality level; engineering proposes more research time with little incremental performance; production claims the design is unmanufacturable; and most importantly, should the project be aborted?

The engineering manager is usually alone in his task, facing dissention from every quarter, and principally dependent upon intuition for decisions that could wreck his career. Here, if nowhere else, let us salute the lonely bull for his courage and spirit as he daily enters the ring fighting the good fight, without spectators to appreciate his skill, and applause to refresh his soul.

Cable system upgrades

By Martin J. Walker
Vice President, Engineering, Simmons Communications

For many cable systems, a rebuild seems to be the only answer to a multitude of problems. However, often upgrading the system rather than rebuilding it would yield far more benefits per dollar spent, and might accomplish a majority of the objectives at far less cost.

All upgrades aren't rebuilds

A rebuild is, as its name implies, the construction of a complete cable system to replace the one that is presently operating. An upgrade, several years ago, implied merely the changeout of some or all of the plant electronics, either by modification to the existing modules, or by module replacements. Today, an upgrade means much more. For our purposes, an upgrade will be defined as the improvement of performance and/or the increase of channel capacity of a system by the replacement of specific elements of the system on a planned basis. That's quite a mouthful, but simply put, it means "if it ain't broke, don't fix it!" A well-planned upgrade focuses on those areas of the system that absolutely must be improved to accomplish the desired objectives, whether they are to increase channel capacity to a predetermined level, to provide better quality pictures, to achieve better system reliability, to reduce service calls or to improve public relations.

There are pros and cons to both rebuilding and upgrading. An obvious pro for an upgrade is that it costs less. Since this consideration may override all others, it clearly must bear the most weight. An upgrade also can take less time to accomplish than a rebuild, depending upon its complexity. There are drawbacks however. The amount of planning for an upgrade, as well as the information acquisition and analysis necessary, could make the total time frame for the project longer than a rebuild would have taken. An upgrade can be far more disruptive to subscribers than a rebuild, because the existing system is having extensive improvements made to it. In many cases, an upgrade cannot be as design efficient as a rebuild, and the resulting system may not be as efficient or economic to maintain. Despite these drawbacks, an upgrade may be the way to go.

It is important to remember that whatever is done should be designed to last 15 years or more—the average lifetime of the electronic portions of the plant. To do any less will probably end up costing more in the long run.

Keep your goals in sight

The most important thing to keep in mind during the planning process for an upgrade are your objectives or goals. These usually will fall into several main areas—marketing, economic, technical and political. All of these areas are closely interrelated and it is impossible to deal with any of them in a vacuum. It is necessary to consider the effect that each of these has on all the others when setting goals.

Table 1

Forward bandwidth (MHz)	Channel capacity
216	23
270	32
300	37
330	42
400	54
440 (450)	60 (62)
550	80
600	88

All capacities include channels A-1 and A-2. Bandwidths 400 MHz and higher include channel A-8 due to HRC operation.

Unless the political climate has deteriorated to the point where an upgrade must be done to avoid losing a franchise, or unless a franchise renewal was granted predicated upon an upgrade, marketing goals will become the driving factor behind the entire process. The most logical starting point is to decide what services will be offered on the upgraded system, in both the immediate future and several years down the road. This will determine the necessary channel capacity in the upgraded system, and in fact will determine if rebuilding is a viable alternative. It also will be important to know how many of these channels will be pay services, what sort of tiering (if any) of these channels will be done, how they will be marketed and what penetration levels are projected.

Marketing goals are very closely tied to economic goals. The new services planned will generate new revenues, which will be used to pay for the upgrade (as well as hopefully to make some profits for the company). These revenues, combined with the project capital costs, will create a return on investment that must be designed to meet corporate needs. They also will determine if money is even available to do the upgrade.

Technical goals should focus on improvement of the system in such areas as leakage, outage reduction, meeting required performance standards (FCC or otherwise), service call reduction, and, ultimately, subscriber satisfaction. This in turn will make subscribers more receptive to new services, thus making it possible to meet marketing goals.

No upgrade should be considered without keeping the political climate in mind. An upgrade might be useful in obtaining a franchise

renewal or extension. A renewal or extension can help tremendously in obtaining financing to pay for the rebuild, so the effect your political goals have on your economic goals can be tremendous. It also might be helpful to allow elected officials to get some political mileage out of the upgrade, particularly if they are running for re-election any time soon.

Decisions, decisions

The upgrade planning process is full of decisions that must be made. However, the more time spent planning, the easier the execution will be when you swing into action. The most basic decision deals with system bandwidth and channel capacity.

There are numerous bandwidths that have become "standard" in that the vast majority of cable systems in the United States use them (see Table 1). It is likely that one of these bandwidths will be chosen as the upgrade channel capacity, due to the availability of standard electronics for them. Some options are not realistic to consider for an upgrade. It is unrealistic to expect to upgrade a 12-channel system to 80 channels, whereas 23 or 32 should definitely be attainable. A 37-channel system would be a good candidate for upgrading to 42 or 54. An unrealistic expectation will only lead to problems further down the line.

It is often possible to squeeze in extra channels on an existing system without major plant modifications. For example, even a 12-channel system could possibly add three channels without changing even electronics. Channels H and I usually can be safely used with even single ended electronics, because most beats generated will fall outside of their band. Channel J often can be added, depending upon the degree of roll off in the amplifiers and equalizers. Another squeeze that might be accomplished would be the addition of channels A-2 and A-1 to the system already using the other mid-band channels. The addition of channel J is also often possible in many 21-channel systems.

Once the channel capacity has been decided upon, it is then necessary to decide how the channels to be added will be carried. Will all the channels be added to the basic service, or will some of them constitute an optional tier that must be secured? How many pay channels will be added? The quantity and location

Table 2: Trunk and feeder cable losses at various frequencies at 70 F

Cable size	Dielectric	50	216	300	330	400	450	500	550
		Frequency (MHz)							
.412	Polystyrene	.62	1.35	1.63	1.71	1.88	2.00	2.10	2.21
.412	1st generation foam	.75	1.65	2.00	2.10	2.31	2.45	2.58	2.71
.412	2nd generation foam	.71	1.52	1.81	1.90	2.09	2.22	2.34	2.45
.412	Current generation foam	.62	1.35	1.63	1.72	1.92	2.05	2.10	2.21
.500	Polystyrene	.50	1.10	1.32	1.38	1.52	1.62	1.70	1.79
.500	1st generation foam	.60	1.35	1.63	1.71	1.88	2.00	2.10	2.21
.500	2nd generation foam	.56	1.24	1.49	1.56	1.72	1.82	1.92	2.02
.500	Current generation foam	.51	1.10	1.32	1.39	1.55	1.65	1.70	1.79
.750	Polystyrene	.34	.75	.90	.94	1.04	1.10	1.16	1.22
.750	1st generation foam	.40	.96	1.15	1.21	1.33	1.41	1.48	1.56
.750	2nd generation foam	.39	.87	1.05	1.10	1.21	1.29	1.36	1.42
.750	Current generation foam	.34	.75	.91	.96	1.07	1.15	1.22	1.23
.625	Current generation foam	.41	.90	1.08	1.14	1.27	1.35	1.44	1.46
.875	Current generation foam	.30	.66	.80	.85	.94	1.01	1.07	1.08
1.000	Current generation foam	.27	.59	.72	.77	.85	.92	.98	1.03

Cable losses will vary ±1 percent/10 F temperature change.

To find losses at any frequency, use $L_{unknown} = L_{known}\sqrt{\frac{F_{unknown}}{F_{known}}}$

of both pay and tier services will be an important factor in the cost of providing security for these channels, so a channel lineup and marketing plans must be decided upon early in the process.

Another item that would be worthwhile to consider is advertising sales. Revenues generated from sales of avails on satellite channels can help provide revenues to pay for the upgrade. But they also require additional capital for equipment and additional rack space in the headend. It is important to know early on if ad sales are expected to be an integral part of the upgrade.

During the process of making the marketing decisions, other questions will arise that will necessitate further decisions. Already mentioned previously is security—how can the system revenues be protected by minimizing unauthorized reception of the signals? For that matter, how can all the channels be provided to all subscribers, including those who do not have cable-ready sets?

The starting point for both of these questions would be the converter that is to be provided to the subscribers. This decision is an important one because a large portion of the upgrade dollar will be spent on converters and security. There are many factors that must be taken into account here. What is the expected penetration for each of the services to be added? How many channels need to be secured? What is the cost per converter and/or trap? What degree of security is desired? What is the anticipated churn? How much will the converters and/or traps cost to install, and to maintain? All of these questions need to be answered. In general, the higher the penetration expected, the more cost-effective cheaper converters and traps will be, while for lower penetrations combined converters/descramblers will prove to be the better choice. For higher churn situations, converter/descramblers will be better, because subscribers must bring the box in for a service change.

Along with a decision on the basic converter/security concept, the type of converter must be decided upon. If traps are to be used, should the converter be a block converter or a single-channel output? If converter/descramblers are to be used, should they be RF or baseband units? Should they be single-mode or dynamic-mode scrambling?

Addressability should not be ruled out. One-way addressability is both practical and possible in the upgraded system, and should be seriously considered for high churn environments with multiple service levels. Two-way or off premise systems are probably not viable unless a complete rebuild is contemplated. The downside to addressability is, of course, the converter cost.

Another major area where decisions must be made is at the system headend. To fill up those new channels and add that new programming, signal reception and processing equipment must be added. Aside from the pure economics of purchasing the equipment, careful consideration should be given to the physical requirements of adding the equipment to the existing racks and building. Pay attention to such things as rack space, floor space, heating and cooling, and power requirements inside the headend. An addition to the space should be made if needed. Outside, the availability of land may dictate whether or not a separate dish, multi-beam feed, or Simulsat-type is used for additional satellite channels.

If microwave-fed signals are to be added, a critical item is the load bearing strength of the tower. If it won't hold the dish needed, can appropriate starmounts or other tower strengthening be done to solve the problem?

Probably the most complex decision making will involve the outside plant. It is here that the largest single portion of the upgrade dollar will be spent. The larger the portion of the existing plant that can be saved, the more cost-effective the upgrade will be.

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Reader Service Number 13.

Table 3: Amplifier spacing using current generation foam cables

Amplifier operating gain	Cable size		Frequency (MHz) 216	300	330	400	450	500	550
22 dB	.412	Spacing in feet	1630	1350	1279	1146	1100	1048	995
22 dB	.500		2000	1667	1583	1419	1333	1294	1229
22 dB	.625		2444	2037	1930	1732	1630	1528	1507
22 dB	.750		2933	2418	2292	2056	1913	1803	1789
22 dB	.875		3333	2750	2588	2340	2178	2056	2037
22 dB	1.000		3729	3056	2857	2588	2391	2245	2136
26 dB	.412		1926	1595	1512	1354	1300	1238	1176
26 dB	.500		2364	1970	1871	1677	1576	1529	1453
26 dB	.625		2889	2407	2281	2047	1926	1806	1781
26 dB	.750		3467	2857	2708	2430	2261	2131	2114
26 dB	.875		3939	3250	3059	2766	2574	2430	2407
26 dB	1.000		4407	3611	3377	3059	2826	2653	2524

In all likelihood, the majority of the plant electronics will not be salvageable, except for plant extensions or amplifier replacements that might have been made with equipment that will pass the entire new desired bandwidth. If the system upper bandwidth limit is increased, it also is unlikely that many of the passives and connectors can be salvaged, due to design changes in the plant.

It is far more likely that much, if not all, of the cable, strand and hardware can be saved, which is extremely important since that is where the majority of rebuild plant costs lie. Let us now examine each of the major plant components, and discuss in detail some of the information needed and questions to answer to make decisions on what can and can't be salvaged.

Trunk electronics and design

It is likely that some form of replacement of plant electronics will need to be done since the system was probably designed to take advantage of the electronics' full bandwidth at the time it was built. The major ways to realize cost savings in this area will be in the use of replacement modules and/or modification kits to be added to the existing modules, and in retention of the existing amplifier modules.

The following questions were designed to provide the information needed to decide how much (if any) of the existing electronics and design can be retained. It is assumed that an adequate system as-built map is available.

1) What will the system's new upper bandwidth limit be? Is it the same as the present one, or is it higher?

2) If it is higher, will the present modules pass this bandwidth? If so, what about the amplifier chassis, equalizers and pads? Sweep testing should be performed to determine this information. Quite often, particularly on older equipment, the manufacturer's specifications can be exceeded.

3) If available, what are the manufacturer's specifications for the equipment? Important items are module gain, station gain, noise figure, and distortion specifications at rated output, particularly with full loading of the planned number of channels.

4) What is the power consumption of the modules? Can they operate at both 30 and 60 volts? If they can be switched either way, what is involved in the switch?

5) If replacement modules or modification kits are available, and the existing modules will not be retainable, what are the answers to the questions in 3) and 4) for the replacements?

6) Is the physical integrity of the amplifier housings for water leakage, thermal dissipation, and RFI leakage such that use of available replacement modules and/or modification kits make sense, or should the housings be replaced? If they should be replaced, it may make more sense just to buy complete new stations.

7) Will the existing system power supplies, operating at their present location and voltage, be able to handle the power requirements of the new modules? Can they be switched to 60 volts to allow for lower current draw? Is their physical condition such that they should even be considered for retention? Should they be upgraded by the addition of surge protection, time delay relays, or standby capabilities? All of this assumes retention of the present amplifier locations, which may not be possible, as we shall soon see. If the present power supplies are not metered, this is a good time to have them done.

8) What is the present trunk cascade? What will the worst-case performance to the subscriber be, assuming new electronics in the present location? If it does not meet acceptable minimums, a trunk redesign is necessary.

9) What pilot carriers do the present modules use, and what will the replacements use? If they are discrete carriers, will this render any channels unusable?

10) Can any trunk rerouting shorten cascades and improve system performance?

11) Is the trunk bonding and grounding adequate, or should additional verticals and/or bonds be added? The preferable situation would be to have verticals one pole away from each active station, in every direction.

12) What is the present automatic gain control (AGC) spacing between AGC stations? AGC every third station may have worked just fine for your 12-channel system, but it will need to be decreased to at least every second station for expanded bandwidth.

Trunk cable

1) Now we come to the heart of the matter. What is the existing trunk spacing, in feet, between stations? What type of cable is each section? What is the cable loss, in dB, at both the present highest frequency and proposed highest frequency? These should be determined using both manufacturer's specifications and by actual sampling, testing several sections of the plant. At the same time, the signal return loss (SRL) of these sections should be checked across the entire bandwidth of interest, to ensure that all desired channels will be useable. Make sure to check all older types of cable in the system. If manufacturer's specifications are not available, Table 2 may be used as a guideline to determine what the cable attenuation should be at various frequencies. Maximum, rather than nominal, attenuation specifications have been

Reader Service Number 14.

Table 4: Drop cable losses at various frequencies at 70 F

Cable size	Dielectric		Frequency (MHz) 50	216	300	330	400	450	500	550
RG-59	Foam	Loss in dB/100 feet	1.78	3.59	4.27	4.47	4.98	5.30	5.61	5.89
RG-59	Solid		2.22	4.72	5.62	5.89	6.49	6.88	7.26	7.61
RG-6	Foam		1.43	2.90	3.46	3.62	4.04	4.31	4.57	4.71
RG-6	Solid		1.77	3.80	4.52	4.74	5.22	5.54	5.84	6.12
RG-11	Foam		.87	1.88	2.24	2.34	2.61	2.78	2.95	3.10
RG-11	Solid		1.20	2.61	3.12	3.27	3.60	3.82	4.03	4.22

used, to allow for increases due to aging.

2) At the same time the above testing is being performed, a physical check of the entire trunk should be performed. Are there excessive splices, sheath cracks, corrosion, storm damage, bullet holes, water damage or other defects that might render certain sections of cable unuseable? If so, you should plan on replacing these in any event and so mark them on the map. If any particular type of cable has had a history of maintenance problems, or has needed frequent replacement, you should plan on replacing all of that particular type of cable as well.

3) After you have determined which cable will definitely be replaced due to problems, it is time to deal with the remainder. The objective here is to preserve as many of the present trunk locations as possible, to avoid having to make extensive feeder changes, to preserve existing cascades where advantageous, and to preserve existing power supply locations. It is helpful at this point to note the spacing, in dB, at the new upper bandwidth limit between each station in the trunk. This will determine if standard gain modules may be used throughout the system, or if some or all increased/high gain modules must be used. If amplifier spacings exceed the maximum station gain of the available amplifiers chosen for the new system, it may be necessary to replace certain trunk sections with current generation cables to shorten the spacing between stations. Table 3 denotes station spacings in feet for current generation cables at various frequencies.

4) If it has been possible to preserve all amplifier locations due to use of higher gain/higher output capability amplifiers and/or cable replacement, then the performance calculations done previously are still valid. If not, a recalculation using the new trunk design should be performed. Unless there have been major changes in design, there should not be a major performance difference. If conventional push-pull amplifiers cannot meet desired performance objectives, then serious consideration should be given to advanced technologies such as feedforward and parallel hybrids.

5) It would also be a good idea at this time to look at any potential system extensions, and make sure that the extended system will perform in as satisfactory a manner as the existing system.

Feeder electronics and design

If the system upper bandwidth has not changed, and the trunk locations have been preserved, it probably will not be necessary to do any more than upgrade the active electronics and replace any defective items in the feeder plant. If an expanded bandwidth is to be used, however, a more detailed analysis is necessary.

1) What is the bandwidth of the existing taps and passives? Representative samples of each type should be checked to see what they will pass. (Don't automatically write off pressure taps, either—one system that was upgraded in 1980 successfully passed 260 MHz through a multitude of pressure taps, with less through insertion loss than directional taps.) Other items to check include through loss and tap loss across the entire band, flatness of response, return loss, RFI leakage integrity, port-to-port isolation, capability of the device to pass 60 V as well as 30 V without excessive hum, and overall condition of the devices. If the devices are clearly in poor physical condition, they should be replaced without any question.

2) What is the feeder cable loss at the new high frequency? Since feeder cable is typically broken up by taps and passives much more frequently than trunk, it will probably not be necessary to replace any of it unless physical problems exist. In order to check the distribu-

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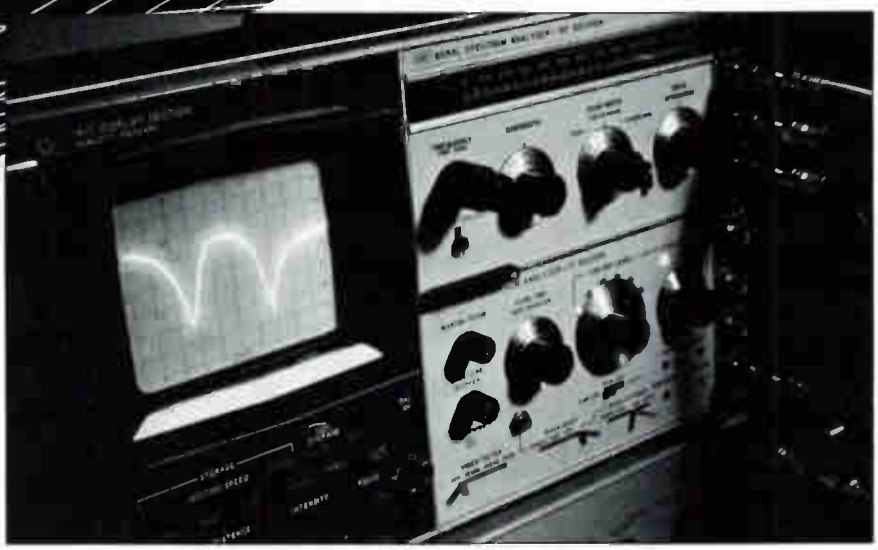

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tion design at the new upper bandwidth frequency, the cable should be checked for attenuation.

3) What is the existing line extender spacing? Will the new line extenders work in the present locations, with proper input/output levels, or must they be respaced? Be sure to check power supply loading in both cases, as the new line extenders probably will draw more current than the old ones. If the system currently operates with more than two-three line extenders per mile, you probably will benefit by respacing.

4) What is the present line extender cascade length? If it exceeds two in cascade, it is beneficial to see if the cascades can be reduced, due to increased distortion and due to AGC limit considerations. If feeder redesign cannot accomplish this, trunk extensions should be considered.

5) What will the tap output levels at the new upper bandwidth limit be, and at channel 2, with the new bridger and line extender levels and locations? Will the output levels provide sufficient levels for all subscribers, particularly for multiple outlets (which are on the rise, due to VCRs)? Typically, tap outputs need to be at least 2 dB higher at 300 MHz than at 216, and 3 dB higher at 400 MHz. The alternative to this would be to change to a lower loss drop cable. For example, if existing drops are RG-59 solid dielectric in a 216 MHz system, a switch to foam dielectric would result in an almost identical loss at 400 MHz (see Table 4). Drop replacement, however, may not be as cost-effective as a feeder redesign, particularly if a large number of taps are already planned for replacement. Also, don't forget, reverse feeder tilt and converter overload in line equalizers, which were not needed at 216 MHz, but become a very real fact of life at 300 MHz and above. Tap outputs are also very critical when scrambling, to ensure proper descrambling operation.

6) It's also a good idea to check your house counts when doing your feeder checks. Hopefully, you will add new basic subscribers when you add the new channels, and you want to be able to feed them. It is also a good idea to eliminate any drop splitters on the existing tap ports, to make sure levels to all subscribers are correct.

Connectors and leakage

All new taps, drops, passives and amplifier housings should have new connectors with integral RF sleeves placed on them when splicing. Proper anti-corrosion and waterproofing measures should be taken. If the system has not been doing regular leakage monitoring and correction, a 100 percent system sweep at this time would be a good idea. Any location needing new connectors also should have the tap or passive at that location replaced at the same time, to avoid future problems if the device is borderline.

Drop replacement can become a very expensive portion of an upgrade, but must be done if they will not meet leakage specifications, or if there are significant maintenance problems with them. Areas to look at include age, condition, splices, usable bandwidth, grounding to electrical codes, improperly wired apartments, and leakage. It would also be a good idea to examine such things as drop tagging, locking terminators and security shields at this time.

Cost-effective planning

After the analysis described herein has been done, a detailed capital budget can be prepared. If you compare this with the budget for a complete rebuild of the system, it will be realized that significant cost savings can be found. The amount of these savings will be directly proportional to the amount of time spent in analysis and planning.

Martin Walker is a veteran of nine years in the cable industry. Prior to joining Simmons Communications in early 1983 as vice president, engineering, he served with ATC, Warner Amex and Harte Hanks in a variety of positions, including director of engineering. He has upgraded more than 20 systems, ranging in size from 500 to 40,000 subscribers.

warehousing, inventory control, electronics, pre-testing, and system alignment and proof-of-performance. The major component prices are broken down as follows:

Electronics per mile	$2,030
Passives and taps per mile	522
Cable per mile	597
Connectors per mile	296
Hardware per mile	65
Labor per mile	1,904
Total construction per mile	$5,414

The final step in the process is to plan a good customer information campaign through local media and access channels, along with a method of handling expected customer complaints and phone calls. We have budgeted $3 per subscriber for this purpose yielding $153 per mile in cost.

Tabulating the cost areas the total rebuild retrofit cost will be $6,200 per mile. Using a cost-per-channel-per-subscriber guideline our capital investment (excluding converters if required) will be $6.39 per subscriber per channel added. A radical rebuild including new construction, removal of old plant, drop swings, and pre-engineering for the same plant would run $14,950 per mile and yield 54 channels thus the cost per subscriber per channel added would be $8.88 or a 39 percent increase over retrofit. If the excess channels above the 40 yielded by retrofit are in fact overhead for future, the real cost per active channel would be $15.42 or 2.5 times the retrofit cost.

It is easy to see that the critical step in determining the type of rebuild will be to determine what end result is desired. Many decisions have been based on the emotions of the situation at hand without having the full data to make a rational decision. Not every system needs to have a 54+ channel capacity to properly serve its subscribers. Consider this: At a $6.39 per-channel per-subscriber cost, each unused channel in a 500-mile system will represent an investment of $162,945 in plant cost. At the $8.88 for radical rebuild the plant investment will be $226,440 per unused channel.

The final factor that must be considered in the cost analysis is the subscriber audit. In the case of the radical rebuild this step can be taken at any time prior to transferring the drops from the old plant to the new plant. In the case of the retrofit this step must be completed prior to work starting in an area.

In the final analysis, the retrofit rebuild process can be very cost-effective if proper pre-planning steps are taken, cost areas are well-defined and, perhaps most importantly, areas of responsibility are properly assigned. As with any major construction project divided responsibilities lead to confusion and misunderstandings. In the retrofit project the results are immediately felt because subscribers are affected on a current basis.

It also should be understood that not all systems can be retrofit rebuild due to configuration, cascade lengths or cable degradation. If your system has been well-maintained and extensions have been added to meet the original design criteria, in most cases you will find that available gain versus performance technology (i.e., power doubling and feedforward) coupled with lower loss passive devices will allow frequency extension on a retrofit basis in a cost-effective manner.

The prices given in this article are based on a specific system analysis and will vary widely from system to system based on the particular requirements. They are provided for example only.

Table 1

Cable size	0.750" gas-injected	0.875" gas-injected	1.000" gas-injected	0.750" air dielectric
Attenuation (dB/100' @ 400 MHz)	1.06	0.91	0.84	0.91
Total loss (dB @ 10 miles)	560	481	444	481
# amplifiers @ 22 dB	26	22	21	22
Cable cost/1,000'	$ 340	$ 430	$ 605	$ 370
Total cable cost	$17,952	$22,704	$31,944	$19,536
Amplifier cost ($800 each)	$20,800	$17,600	$16,800	$17,600
Total cost	$38,752	$40,304	$48,744	$37,136
Percent difference	reference	3.9%	20.5%	-4.4%
Cascade factors (dB)				
Synchronous—CTB, XM	28.3	26.8	26.4	26.8
Random—noise	14.15	13.4	13.2	13.4
Distortion improvement (dB)				
C/CTB	reference	1.5	1.9	1.5
C/N	reference	0.75	0.95	0.75

*Courtesy of Frank Ragone, Comcast Cablevision Corp.

'It is possible to build plants today capable of 600 MHz bandwidth, but that doesn't mean that it is practical to do so'

Fundamental processes in upgrades or rebuilds

Many technicians and engineers are considering an upgrade or rebuild of their plants in an effort to provide more channels and better service to their subscribers and increased revenues to the system owners. This article, in outline form, will attempt to provide some guidance in addressing some areas of concern when implementing such projects.

By Dave Franklin
Vice President, Engineering, Adelphia Communications Corp.

The successful execution of any new-build, rebuild or upgrade project is largely dependent upon the amount of consideration given to the fundamental processes outlined below.

Maps

I) Maps can be divided into two classes: strand or "as-built."

A) Strand maps are required in new-build, extension or rebuild situations. They show pole-line information including routing, pole ownership and configuration, footages and house counts.

B) As-built maps are required in system upgrades. They provide existing plant information to include equipment placement, type (i.e., directional coupler vs. splitter) and value (i.e., tap value or line extender gain). This information is in addition to that given by the basic strand maps.

II) All maps should show the following information:

A) Existing or proposed trunk routing.

B) Natural or man-made obstacles or barriers (i.e., power transmission lines, rivers, etc.).

C) Design instructions—maps should be surveyed and marked to indicate: 1) design—build; 2) design—do not build (for possible future expansion); and 3) do not design.

D) Existing or proposed institutional networks or return lines/paths.

E) Apartments/multiple dwellings—show separate buildings, with dwelling units, and distribution feed points.

F) Newly constructed plant sections of adequate bandwidth/channel loading capacity to be incorporated in the new system.

Design objectives

I) With any new-build, rebuild or upgrade project, these design objectives should apply: A) low signal distortion, B) minimum number of active components, C) short cascades, D) low cost, E) high reliability, F) low maintenance requirements, and G) future growth reserve.

II) These objectives are interdependent so that adjustments to one will affect some or all others. The ultimate design objective is to balance these items so as to deliver good quality pictures for the greatest period of time with the least effort and cost. Consider the following when designing the new plant.

A) Desired bandwidth/channel capacity—it is possible to build plants today capable of 600 MHz bandwidth, but that doesn't mean that it is practical to do so. Consider your present channel loading, the physical area you need to cover and new program requirements when determining your proposed design bandwidth.

B) Distortion limits/system levels—signal distortion is directly related to system levels. As input levels decrease, signal carrier-to-noise ratio (C/N) degrades and pictures become "grainier." As output levels increase, cross-mod (XM) and composite triple beat (CTB) performance degrades and pictures begin to show interference. Typical design distortion limits are as follows:

Carrier/noise (C/N) = 43 dB
Second order (SO) = 60 dB
Cross-mod (XM) = 54 dB
Composite third (CTB) = 53 dB
Low frequency (hum) = 34 dB or 2 percent

Note: In expanded frequency systems (450 to 600 MHz) composite second order distortion becomes a limiting factor.

C) Channel assignments—alternate channelization plans provide some degree of excess "headroom" in distortion limits/system level determination. There are three channelization schemes currently in use; these are as follows:

1) Standard—uses standard FCC channel assignment with the picture carrier set 1.25 MHz above the channel's lower band edge.

2) Incrementally related carrier (IRC)—uses a frequency stable comb generator to phase lock all channels (except 5 and 6) to the standard FCC channel assignments. Channels 5 and 6 are also phase locked, but their frequency bands are offset 2 MHz to give multiples of basic 6 MHz separation. All channels are operated with the picture carriers set 1.25 MHz above the lower band edge. IRC yields a subjective distortion improvement of 3 to 6 dB, which allows output level increases of 1 to 3 dB.

3) Harmonically related carrier (HRC)—uses a frequency stable comb generator to phase lock all channels to a multiple of 6 MHz. This technique moves the picture carriers to

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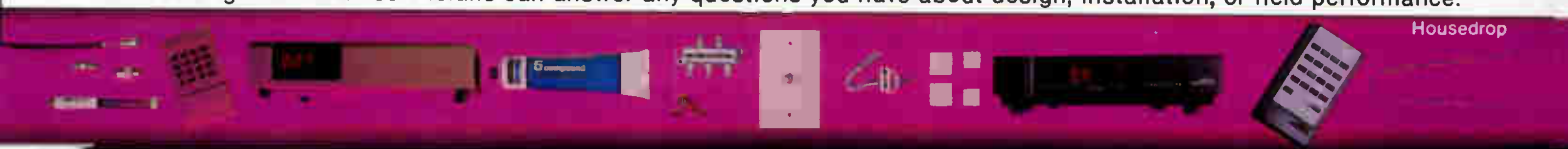

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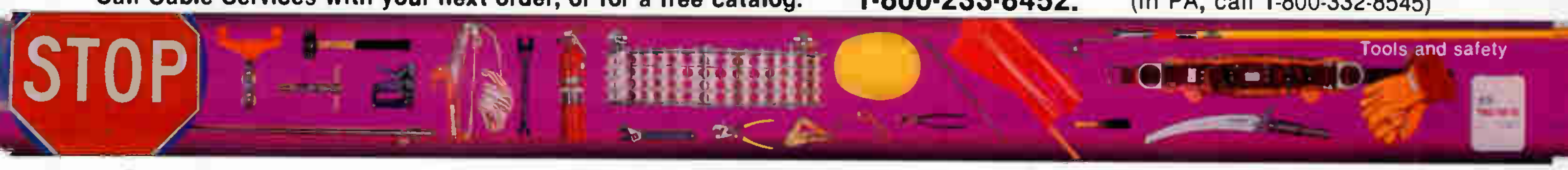

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the FCC assigned channel band edge (i.e., channel 2 moves to 54 MHz from 55.25 MHz). This technique yields a subjective distortion improvement of 4 to 8 dB, which allows output levels to increase 2 to 4 dB.

Use of an alternate channelization plan may allow you to implement an upgrade at a lesser cost than a complete rebuild by enabling you to use higher output levels in the new plant.

D) System automatic level control (ALC) —judicious use of system ALC will provide increased reliability and stable picture quality. The system's typical temperature range should be determined and the system should be designed to operate satisfactorily within this range.

Most current systems employ standard video carriers as trunk system pilots, using one pilot in the low-band for slope control and one pilot in the super-band (channels J to W) or the hyper-band (channels Z-A to 2-0) for gain control. Pilot frequencies should be chosen carefully as they will be responsible for maintaining system levels throughout the trunk system for the life of the plant. Most manufacturers have standard pilot frequencies, with other frequencies available at an added cost. Where possible, standard frequencies should be utilized to avoid unnecessary confusion and expense.

Carriers chosen for system pilots must be very stable in both frequency and signal level. It is desirable to avoid the use of off-air signals, especially distant signals subject to deep fades and low-quality UHF carriers. High-quality modulators provide reasonably stable carriers for system pilots, and these should be used whenever possible. The video source for these modulators should be from a constant (24-hour) feed, not subject to time or tone switching. Under no circumstances are scrambled or encoded video carriers to be used.

Distribution level control is generally accomplished through thermal compensation schemes. This is generally adequate for most applications where line extenders are limited to cascades of two or three. Do not use thermal compensation in underground plants. Equipment exposed to the temperature variations of the elements will not track the buried cable temperature variations.

Upgrade vs. rebuild

The decision to uprade or rebuild a plant is dependent upon many factors, each with a varying influence determined by the desired result. Listed below are some of the considerations that should be addressed when making this decision.

I) Mechanical condition of existing plant

A) Strand and hardware: Good quality strand and hardware, handled properly, should last approximately 30 years.

B) General plant construction requirements: 1) adequacy of current anchoring; 2) adequacy of current bonds and grounds; 3) broken lashing wire; and 4) make-ready clearance violations.

C) Factors regarding cable: 1) size and generation; 2) return loss measurements to desired frequency limits; and 3) cable reflexure during equipment changes and splicing.

D) System power requirements: 1) existing power supply capacities—voltage (60 VAC capability?) and current (14 amp capability?); 2) new equipment power requirements; 3) power passing capability of existing system passives; and 4) troublesome power supply locations (standby power?).

E) System taps and passives: 1) desired tap level—typically 11 dBmV at 330 MHz or 12 dBmV at 400 MHz with not less than + 7 dBmV out on the lowest carrier; 2) reverse tilt—output level of lowest frequency carrier should not exceed that of highest frequency carrier by more than 4 dB; and 3) allowance for long drops—typically 4 dB.

F) Drop maintenance: 1) transfer or change-out existing drops; and 2) provide adequate drop bonding at time of transfer or change-out.

General design considerations

I) System configuration

A) Trunk/feeder configuration: 1) single trunk/single feeder; or 2) dual trunk/dual feeder.

B) Back feeds or express feeders allowed: 1) aerial—allows for longer distribution runs, greater reach; or 2) underground—could mean difference between trenching and plowing, added expense.

C) Extension requirements—tie into existing trunk runs.

D) Reverse feed requirements: 1) point-to-point; and 2) multipoint-to-point.

II) Design technology—the choice of which distribution technique and cable type to use is affected by many competing factors, but the prime consideration must be cost versus performance. Generally, if your system can be adequately served using conventional push/pull hybrid amplifiers and standard .750" trunk and .500" feeders, your choice is simple. If, however, the physical size of your system and the desired bandwidth are such as to deny the use of these products, you must balance the following alternatives.

A) Alternate amplifier technology:

1) Power addition techniques—as system bandwidth and channel loading increased, cross-modulation and composite triple beat distortions worsened. To compensate for this effect, systems levels, especially distribution levels, were decreased and operational tilts were increased. This in turn called for lower tap values to be used (to maintain minimum signal level outputs), which caused an increase in tap insertion loss. In addition to the higher insertion losses of the lower value taps, additional loss was incurred at the wider bandwidths. Taps and passives began to show a significant amount of tilted loss (similar to cable attenuation), which further aggravated feeder design. All of these causes (lower levels, greater tilt, greater insertion losses) contributed to a shortening of total feeder length that caused a decrease in the system's feeder/trunk ratio (as more trunk was required to reach places where feeder could no longer suffice), which was reflected in higher total system cost.

In an attempt to recover the desired output level capability, a technique using parallel amplifiers in a power addition circuit was developed. This technique provides approximately 2.5 dB more output capacity without adding significantly to the distortion products. As system bandwidth continues to increase (i.e., from 400 MHz to 600 MHz) some manufacturers are considering the use of parallel power addition circuits to maintain the required distribution levels.

2) Feedforward techniques—feedforward amplifiers incorporate an error amplifier, delay lines and directional couplers configured to cancel distortion products generated in the main amplifier. This technique provides significant improvement in carrier to cross-modulation and composite triple beat ratios, approximately 12 dB to 15 dB. Due to nonlinear amplification characteristics, we are not able to fully utilize this improvement in increased signal output capability; we traditionally use this improvement in long distance signal transportation (super trunks) to provide for distribution hubs or isolated population clusters.

3) Ideal utilization—use feedforward trunk amplifiers as required to provide high-quality signal transportation to hub sites, isolated areas and plant extremities. Use power addition bridges and line extenders to maintain distribution output levels. Wherever possible, use conventional push/pull amplifiers to keep capital and operational costs to a minimum.

B) Cable sizes and types:

1) Size—the larger the cable, the less the attenuation, hence the greater distance allowed for a unit of gain. It must also be remembered that larger cables cost more.

2) Type—generally speaking there are only two types of coaxial cable in use today: gas-injected foam and air dielectric tubular. The mechanical properties of both types of cables have improved dramatically over the years to the point where now they are both equally suitable for use as the occasion warrants. As with size considerations, cost versus performance is the prime factor to be considered when deciding which type to use.

A comparison of gas-injected foam cable in different sizes used in identical situations is given in Table 1 to indicate total cost differential. Also included is a comparison of 0.750" air dielectric cable. This comparison should indicate cost/performance considerations that will be useful in your system design project. Using this model, you should be able to more fully evaluate your needs.

Summary

It is hoped that these brief notes and comments will be useful when the task of upgrading or rebuilding a plant is necessary. I must at this time acknowledge the extensive contribution of Frank Ragone, vice president of Engineering for Comcast Cable Corp., for much of the data contained herein. Ragone presented much of the background information for this article to the Delaware Valley Chapter of the SCTE in two sessions during the fall of 1984 and spring of 1985.

Table 1: Cost analysis of Placer County upgrade

A) FM transportation trunk with new distribution actives

1) FM trunk

Cable	=	$26,000
Trunk amplifiers	=	$16,000
FM trunk total		$42,000

2) 35-channel FM headend $81,000

3) New distribution electronics

Type	Quantity	Extended cost
AGC Tk. w/Br	73	$39,000
Man Tk. w/Br	73	31,500
AGC Tk. Only	2	800
Man Tk. Only	2	600
Term dist.	44	16,500
Line ext.	240*	38,200
Tk. P/S	97	8,300
Total distribution actives		$134,900

*Fifty percent of line extenders can pass 300 MHz

4) 35-channel distribution headend $ 56,000

FM trunk with new distribution actives total $313,900

B) Feedforward trunk with conventional line extenders

Type	Quantity	Extended cost
AGC Tk. w/Br	73	$76,200
Man Tk. w/Br	73	69,800
AGC Tk. Only	2	1,800
Man Tk. Only	2	1,600
Term dist.	44	22,100
Line ext.	240*	38,200
Total		$209,700

*Fifty percent of line extenders can pass 300 MHz

C) Power doubling actives

Type	Quantity	Extended cost
AGC Tk. w/Br	73*	$42,700
Man Tk. w/Br	73*	37,200
AGC Tk. Only	2*	800
Man Tk. Only	2*	600
Term dist.	44*	13,600
Line ext.	473	94,600
Power doubling total		$189,500

*Prices include trunk power packs

'Several options for reducing amplifier cascade were explored but those requiring construction of microwave towers or large diameter earth stations were eliminated'

Applying parallel hybrid to a Starline 20 upgrade

By Gerry Anstine
District Engineering Manager, Group W Cable

In the spring of 1984, Group W Cable decided to upgrade its system in Placer County, Calif., in order to add new services with improved technical performance. At that time, the system offered 12 channels of programming to 5,500 basic subscribers. The plant was constructed entirely of aluminum-type trunk and distribution cables, some now approaching 20 years of age. Portions of the distribution system still used pressure taps, and the active components were a combination of Jerrold push-pull and Kaiser single-ended equipment. The last plant upgrade had been done about 10 years earlier by the previous operator, Teleprompter Corp. At that time, a new .750 trunk had been added.

The service area

The area served by our Placer County system extends from the California/Nevada border at the north end of Lake Tahoe, westward around the lake for 14 miles. Since most of the homes in this area are near the lake, there are few sub-trunks of any noteworthy cascade. One of the major obstacles to the upgrade was a result of the nature of this service area; i.e., a long amplifier cascade comprised of 44 trunk amplifiers, a terminating distribution amplifier, and three line extender amplifiers.

Several options for reducing amplifier cascade were explored but those requiring construction of microwave towers or large diameter earth stations were eliminated. This decision was based on the environmentally sensitive nature of the Tahoe Basin, and past difficulties in obtaining special use permits for such facilities. There was good reason to believe that the local planning agency would block efforts to develop a second headend site. Consequently, Group W was forced to limit its evaluation to such options as FM supertrunks, new technology amplifiers and low-loss cables.

Selection of the distribution actives

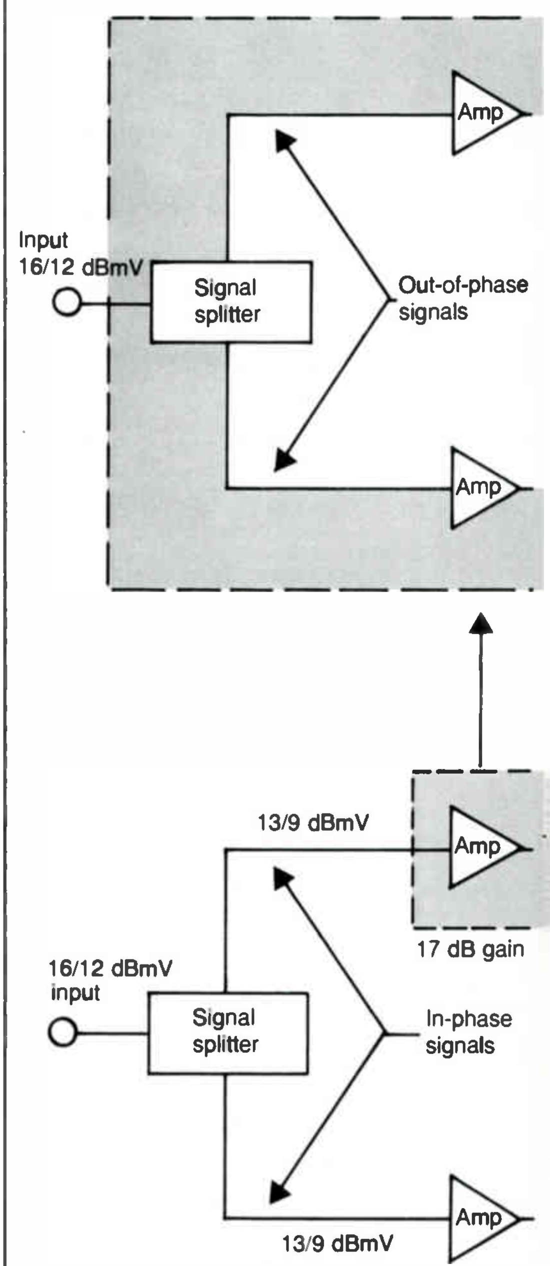
During April and May of 1984, several manufacturers were contacted about equipment specifications, pricing information and options. Technical performance calculations were completed in conjunction with cost analyses. Three options, each capable of 35-channel delivery, were identified: 1) a dual FM trunk approximately seven miles in length with new distribution electronics; 2) new feedforward trunk and distribution amplifiers with conventional line extenders, and 3) power doubling trunk, distribution and line extender amplifiers designed to fit existing Jerrold housings. A total rebuild using new low-loss cables did not appear to be necessary since the existing plant was in compliance with the original design. Also, the other options were more cost-effective and still capable of meeting our proposed performance standards of: a) carrier-to-noise >43 dB at the TV terminals and b) carrier-to-composite triple beat > -53 dB.

Based on the cost analysis in Table 1, the power doubling option was selected since it combined technical performance with the most cost-effective solution. It also provided capability of 40-channel carriage, five more channels than the original objective.

Determining operating levels

A decision was made to leave trunk amplifiers in their current locations. This would reduce outage time and speed up completion of the project. Distribution levels were selected that allowed the current operation to continue without a tap change-out. A linear extension of these levels established the operating levels above 220 MHz. The calculations in Figure 1 demonstrate the expected performance of the distribution amplifiers operated at those levels.

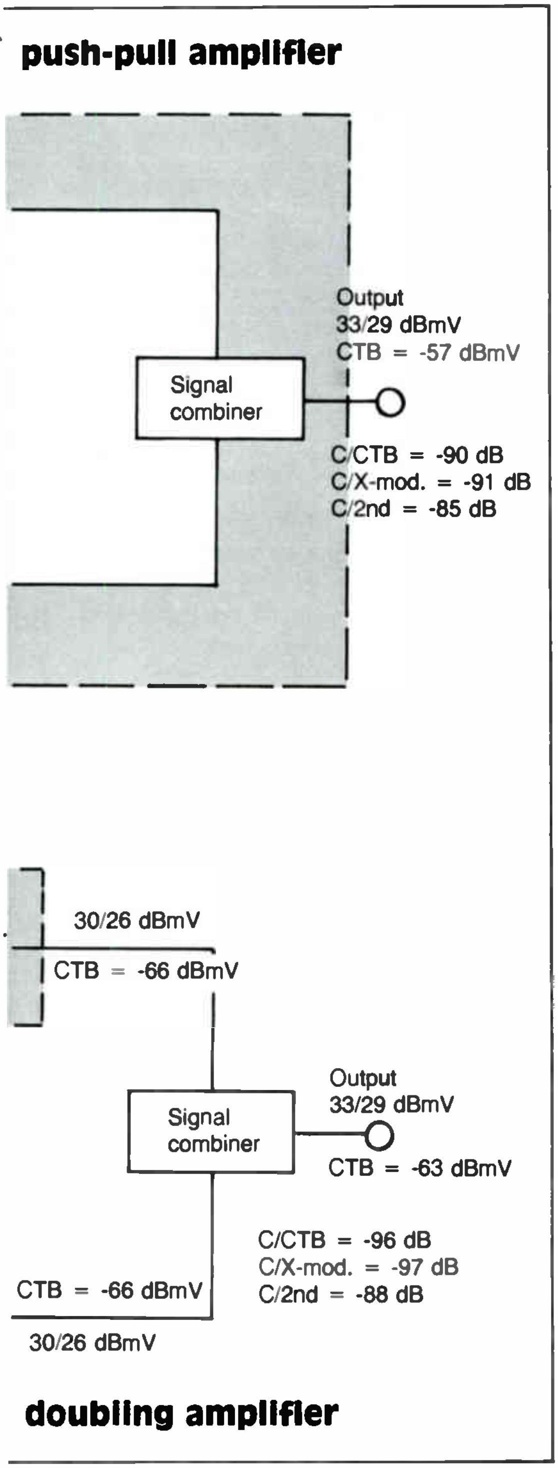
17 dB gain conventional



Theoretical power

With the performance of the distribution system determined, it was possible to assign operating levels to the trunk that resulted in overall plant performance consistent with design objectives.

Once the plant carrier-to-noise performance was established, it was possible to determine the minimum converter input levels that would result in 43 dB C/N at the TV terminals. This compared to our current design resulted in the change of only a few subscriber tap values. Of course, we intended to replace all pressure taps and to gradually configure the distribution for full 40-channel capability. However, it was possible to continue providing current pro-



gramming while complying with our new technical standards, and we were able to do the same for new channels added to the mid-band. Minimum converter input levels are:

C/N at TV terminals = C/N of the plant + (-59.16 dBmV thermal + 14 dB converter N.F. – minimum converter input level)

43 dB C/N = 45.6 dB C/N of the plant + (-59.16 dBmV + 14 dB – minimum converter input)

Minimum converter input =
-10*log(10^[-43/10] – 10^[-45.6/10]) – 59.16 + 14

Minimum converter input = 1.3 dBmV after drop and splitter losses

The upgrade process

Upgrade construction began in August with the installation of the first Quality RF modules. The design included cable testing and repowering to 60 VAC. Since most of the existing passives could not pass the selected design frequency of 330 MHz, testing of the cable was limited to a comparison of the channel 2 and 13 video carriers with calculated losses and cable sweep responses. As new actives and passives were installed, proofs were conducted using a carrier at 330 MHz. To date, less than 2 percent of all cables have required replacement.

Since the start of this project, we have become more sophisticated at cable testing. We test 100 percent of all trunk cable at the highest proposed design frequency before a commitment is made to doing any new upgrades. Of course, this requires considerable

Figure 1: Expected performance of distribution amps operating above 220 MHz

Manufacturer specifications:

Terminating distribution
- Noise figure = 8 dB
- Composite triple beat = -65 dB at 48 dBmV output with 6 dB slope and 40-channel loading

Line extender
- Noise figure = 10 dB
- Composite triple beat = -68 dB at 48 dBmV output with 6 dB slope and 40-channel loading

Group W operating levels:

Terminating distribution
- Input = flat 9.7 dBmV after the equalizer
- Output = 47.5 dBmV at 330 MHz w/6 dB slope

Line extender
- Input = 16 dBmV at 330 MHz and 6 dB slope to 50 MHz after the equalizer
- Output = 44 dBmV at 330 MHz w/6 dB slope

Distribution calculated performance:

Carrier-to-noise
- Terminating distribution = -59.16 dBmV
  - Thermal + 8 dB N.F. − 9.7 dBmV IN = -(60.86 dB C/N)
- Three line extender cascade = -59.16 dBmV
  - Thermal + 10 dB N.F. − 16 dBmV IN + 10*log 3 amplifiers = -(60.39 dB C/N)
  - Terminating distribution w/three line ext. = -10*log(10^(-60.86/10) + 10^(-60.39/10)) = 57.6 dB C/N

Carrier-to-composite triple beat
- Terminating distribution = -65 dB mfg spec − 2*(48 dBmV mfg. output level − 47.5 dBmV Group W output level) = -66 dB C/CTB
- Three line extender cascade = -68 dB mfg spec − 2*(48 dBmV mfg output level − 44 dBmV Group W output level) = -66.46 dB C/CTB
- Terminating distribution w/three line ext. = 20*log(10^[-66/20] + 10^[-66.46/20]) = -60.2 dB C/CTB

Figure 2: Determination of trunk operating levels

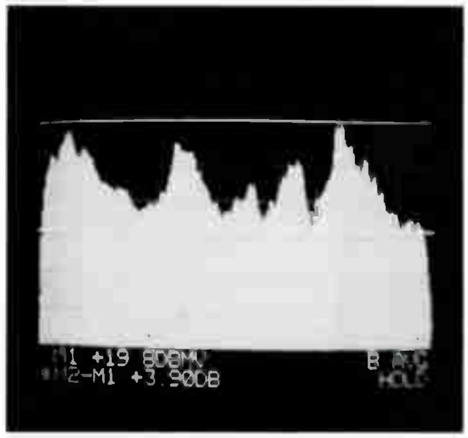
C/CTB of the plant = C/CTB of the trunk + C/CTB of the distribution
-53 dB C/CTB = C/CTB of the trunk + (-60.2 dB C/CTB of the distribution)
C/CTB of the trunk = -53 dB C/CTB − (-60.2 dB C/CTB)
C/CTB of the trunk = 20*log(10^[-53/20] − 10^[-60.2/20])
C/CTB of the trunk = -57.9 dB

C/CTB of the trunk = C/CTB of one trunk amplifier + 20 * log 44 trunk amps
-57.9 dB C/CTB = C/CTB of one trunk amplifier + 20 * log 44
C/CTB of one trunk amplifier = -57.9 dB − 32.87 dB
C/CTB of one trunk amplifier = -90.77 dB

C/CTB of one trunk amplifier = -95 dB CTB mfg. spec -2*(33 dBmV mfg. output level − Group W output level)
-90.77 dB (C/CTB = -95 dB CTB -2*(33 dBmV − Group W output level)
-90.77 dB C/CTB − (-95 dB CTB) = -2*(33 dBmV − Group W output level)
4.23 dB/2 = -33 dBmV + Group W output level
Group W output level = 2.115 dB + 33 dBmV = 35 dBmV at module output

Total plant carrier-to-noise with 35 dBmV trunk output levels:
35 dBmV trunk output − 1.5 dB bridger DC insertion loss − 22 dB spacing at 330 MHz − 1.8 dB equalizer insertion loss = 9.7 dBmV input
Carrier-to-noise of the trunk = -59.16 dBmV thermal + 6.5 dB N.F. − 9.7 dBmV input level + 10 * log 44 trunk amplifiers
C/N of the trunk = -(45.9 dB)
C/N of the plant = C/N of the trunk + C/N of the distribution
C/N of the plant = -10*log(10^[-45.9/10] + 10^[-57.6/10])
C/N of the plant = 45.6 dB

Frequency response for 40-channel loading with a cascade of 44 trunk amps, one high-gain distribution module and two line extenders at 35 F. Response is not corrected for output tilt (6 dB).



End of the line, 8-1-85, 30 MHz to 350 MHz.

time and the replacement of all passives that cannot pass the higher frequencies.

Testing is done at night with highly calibrated attenuators, signal level meters, frequency generators, time domain reflectometers, and summation sweeps. From experience, we have determined that the percentage of bad distribution cable is comparable to the percent of trunk that requires replacement. Therefore, we do not test all of the feeders prior to upgrade construction, only about 10 percent.

The Quality RF equipment used for this project represented the first attempt to adapt power doubling technology to the Jerrold Starline 20 housing. An initial concern was dissipation of heat created by the parallel hybrids. Quality RF appears to have solved this problem by using large heat sinks combined with reduced DC voltages. Some of the equipment has now been in service for a year, and the longest cascade has been upgraded since April. During the last two months, we have experienced many days with temperatures around 95 F. There have been only two failures over the past year, and neither was heat associated.

As with any major project that uses new equipment, there was a need for technical training. Two of the more serious issues we had to prepare for were: equalizer selection

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for an amplifier that uses mid-stage slope, and AGC set-up procedures. Unlike conventional Jerrold equipment, the Quality RF trunk amplifiers operate with a 4 dB slope on the trunk output. This equates to 6.5 dB of internal equalization at 330 MHz. Our designers and line technicians had to be trained in the proper selection of trunk equalizers. Full equalization at the trunk input would have resulted in a loss of almost 4 dB carrier-to-noise at channel 2.

The more unusual problem was the AGC circuit operation. QRF began production with single-pilot AGC/ASC amplifiers which obtained automatic gain and slope control by using a ratio voltage divider that biased the diode attenuator for both operations. This actually simplified AGC set-up, since it resembled that of a single-pilot AGC-only amplifier. However, the QRF unit had another distinction. In order to set AGC reserve, it is necessary to select a proper size plug-in pad that precedes the post-amplifier. Selection of the wrong value causes the AGC window to shift, resulting in less than ±3 dB correction of carrier levels.

Table 2

	Predicted performance	Measured performance
C/N at 330 MHz	45.7 dB	48 dB
C/CTB	-53.7 dB	-58 dB at ch. J
Carrier/second order	-64.3 dB	Not measurable ch. 2, 13, G, R > -70 dB

The system proof

By April of this year, the longest cascade had been upgraded and a decision was made to compare actual performance with predicted performance. In the process of upgrading the plant, a reduction of one line extender was possible on this cascade. New predicted performance calculations were done for the reduced cascade. On April 29, a Dix Hills generator capable of 40 channels was installed at the headend. A Tektronix 7L12 spectrum analyzer was used at the test location. Table 2 compares actual and predicted performance.

Tests also were conducted on the carrier-to-noise at 55.25 MHz, hum and low-frequency modulation, and frequency response. Since the individual amplifiers had better cross-modulation performance than composite triple-beat performance, the NCTA-recommended test for cross-modulation wasn't performed. The results of those additional tests were: C/N at 55.25 MHz = 44 dB; low-frequency modulation = 1.25 percent, and frequency response = 8 dB peak-to-valley.

Our objective for frequency response had been 6.7 dB, or the number of amplifiers divided by 10, plus two. The response problem was identified as overheated RF chokes on the trunk station mainframe. They accounted for 5 dB of roll-off between channels 2 and 5. Since April, we have been replacing the damaged chokes and have reduced the peak-to-valley to 3.9 dB.

Group W intends to continue monitoring the performance of this new equipment over an extended period of time. Arrangements are being made to locate automated test equipment at the end of the longest cascade. Once installed, it will be able to continually monitor performance with respect to temperature and time. These tests will compare video and audio carrier levels, adjacent channel levels, hum modulation, and frequency response. The data will be combined with outage reports and used to determine equipment reliability.

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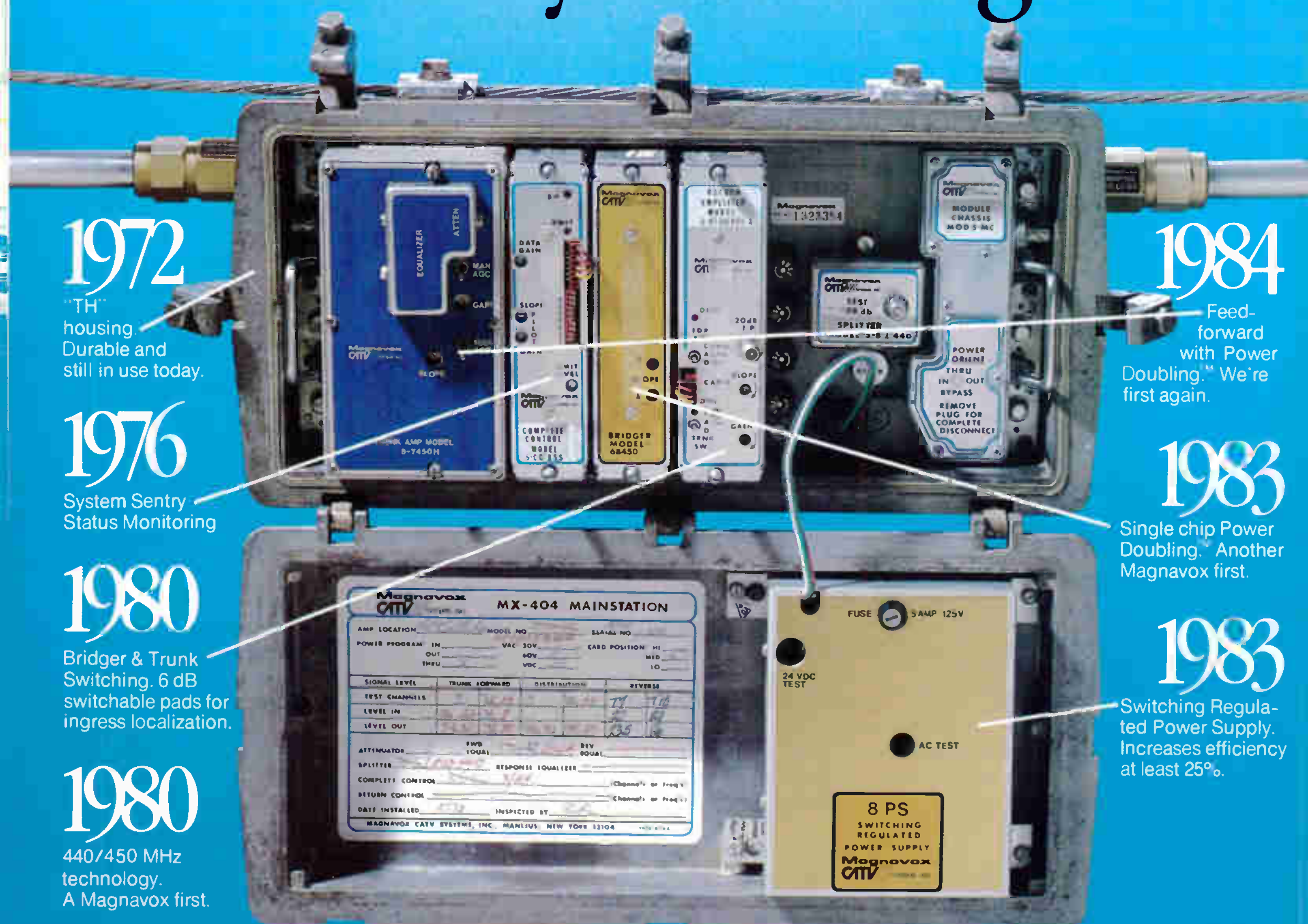

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neous sync of various numbers of channels. The "hours between crash" column gives the average time elapsed between occurrences of the number of syncs. The average duration of a crash would be half the sync duration and could not exceed the sync duration. Thus, in a 12-channel system, the levels would be effective 3 dB or more lower than CW for 93 out of 93.000064 seconds. One-sixteenth of one line out of 5,580 frames would operate with levels effectively higher than this. We could never measure this with our spectrum analyzer methods on composite triple beat (CTB), so it follows that we would say the system CTB was at least 6 dB or more better than with CW carriers. Our "rule of thumb" produced a reasonable system without excessive head room.

With large numbers of independent (random sync) channels, the "rule" probably produces extremely conservative systems in terms of distortion and certainly would in terms of saturation. For the 52-channel case, the effective level is −5 dB versus CW as often as it was −3 dB on the 12-channel system. Thus, there is additional distortion head room as well as an additional 2 dB barrier from saturation. This saturation barrier would be reduced from 2 dB to 1 dB only once for 4.7 microseconds approximately every five years. To think our company trucks were this reliable.

If one does not believe in probabilities, a modified Sruki Switzer approach of sync generator locking and time offsetting syncs would guarantee that no more than five syncs would ever occur simultaneously (at least while the frame grabbers were working).

Table 3: 35 channels, 4.7 μsec sync

# of syncs	Probability of '#' or less	Hours between crash	Effective CW level (in dB)
0	0.06808261695102082	0.0000	−7.00
1	0.25822847057720880	0.0000	−6.80
2	0.51616826851128890	0.0000	−6.60
3	0.74257723113717330	0.0000	−6.40
4	0.88710995126064840	0.0000	−6.20
5	0.95861561464786490	0.0000	−6.00
6	0.98714503965859550	0.0000	−5.80
7	0.99657642634232260	0.0000	−5.60
8	0.99921048941476010	0.0000	−5.40
9	0.99984105461482020	0.0001	−5.20
10	0.99997187816226250	0.0006	−5.00
11	0.99999560368660680	0.0040	−4.80
12	0.99999939010315380	0.0291	−4.60
13	0.99999992466190960	0.2360	−4.40
14	0.99999999169244170	2.1400	−4.20
15	0.99999999918074250	21.6999	−4.00
16	0.99999999992766550	245.7717	−3.80
17	0.99999999999427910	3,107.5238	−3.60
18	0.99999999999959470	43,857.1629	−3.40
19	0.99999999999997420	687,982.7454	−3.20
20	0.99999999999999840	11,043,309.2414	−3.00
21	0.99999999999999980	80,063,992.0000	−2.80

Table 4: 52 channels, 4.7 μsec sync

# of syncs	Probability of '#' or less	Hours between crash	Effective CW level (in dB)
0	0.01845972691496699	0.0000	−7.00
1	0.09505662631896571	0.0000	−6.87
2	0.25091636539184070	0.0000	−6.73
3	0.45820012108507960	0.0000	−6.60
4	0.66082087733657320	0.0000	−6.46
5	0.81603732485624890	0.0000	−6.33
6	0.91305858729357920	0.0000	−6.19
7	0.96393415722411650	0.0000	−6.06
8	0.98676986036304850	0.0000	−5.92
9	0.99567841258238730	0.0000	−5.79
10	0.99873515018878880	0.0000	−5.65
11	0.99966646677952120	0.0001	−5.52
12	0.99992037836933920	0.0002	−5.38
13	0.99998272051394210	0.0010	−5.25
14	0.99999657852437350	0.0052	−5.12
15	0.99999937992870540	0.0287	−4.98
16	0.99999989686867340	0.1724	−4.85
17	0.99999998422135980	1.1267	−4.71
18	0.99999999777495090	7.9898	−4.58
19	0.99999999971031320	61.3690	−4.44
20	0.99999999996513040	509.8361	−4.31
21	0.99999999999611470	4,575.6899	−4.17
22	0.99999999999959860	44,290.8368	−4.04
23	0.99999999999996120	458,491.0064	−3.90
24	0.99999999999999620	4,658,268.6255	−3.77
25	0.99999999999999930	25,620,477.4400	−3.63

Output tilt

The second factor is related to output tilt. Higher output levels produce longer feeder lines. This results in more reverse tilt at the ends of these feeder lines. This problem can be overcome in several ways. The "normal" amount of output tilt (and the one most frequently used in recent studies) is 6 dB. This results in more reverse tilt at the worst case subscriber for reverse tilt, than what is produced in forward tilt for the worst case forward tilt subscriber, and most designers would at least think about installing equalizers to correct this.

Another possibility is to increase the forward tilt at the output of each distribution amplifier. Research by several design companies as well as United Artists Cablesystems concludes that after the "typical drop," a forward tilt of 12 dB at the amplifier would produce a forward tilt of 8 dB at the first set and an inverse tilt of 8 dB at the last set if no equalizers were used. Currently, UACC has several systems operating without the equalizers and without any problems to date. Those who do not wish to have this much difference in level at the set or converter could at least reduce the number of in-line equalizers by increasing the forward tilt somewhat.

Increasing the amount of output tilt reduces the V_{ce} requirements if the output level at the high-frequency channel is held constant. In other words, the probability of saturation is


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reduced. A general rule of thumb suggests and field tests confirm that for each 2 dB the lower-frequency channel is dropped relative to the high channel, the amplifier high-frequency level can be increased by 1 dB and still maintain the same safety factor below saturation.

Table 5: 60 channels, 4.7 μsec sync

# of syncs	Probability of '#' or less	Hours between crash	Effective CW level (in dB)
0	0.00998827977164449	0.0000	−7.00
1	0.05780992609717569	0.0000	−6.88
2	0.17038159731628670	0.0000	−6.77
3	0.34404904705774760	0.0000	−6.65
4	0.54152574905706640	0.0000	−6.53
5	0.71801426964355630	0.0000	−6.42
6	0.84710958303775700	0.0000	−6.30
7	0.92657694027338900	0.0000	−6.18
8	0.96858738000220630	0.0000	−6.07
9	0.98795608729462600	0.0000	−5.95
10	0.99583839503362000	0.0000	−5.83
11	0.99869738927138940	0.0000	−5.72
12	0.99962894896297930	0.0000	−5.60
13	0.99990341660287370	0.0002	−5.48
14	0.99997694304384300	0.0008	−5.37
15	0.99999493559273880	0.0035	−5.25
16	0.99999897360652280	0.0173	−5.13
17	0.99999980758362470	0.0924	−5.02
18	0.99999996656002220	0.5316	−4.90
19	0.99999999460214690	3.2935	−4.78
20	0.99999999918934350	21.9301	−4.67
21	0.99999999988656470	156.7218	−4.55
22	0.99999999998519160	1,200.5161	−4.43
23	0.99999999999819430	9,845.0935	−4.32
24	0.99999999999979380	86,229.3936	−4.20
25	0.99999999999997760	794,679.8213	−4.08
26	0.99999999999999740	6,777,904.0847	−3.97
27	0.99999999999999940	27,848,345.0435	−3.85

Table 6

Equipment count (per mile)

	Trunk actives	Line extenders	Power supplies	Trunk cable
Conventional	0.93	2.54	0.25	1528 ft.
Feedforward	0.34	1.66	0.23	782 ft.

System performance (measured)

	CTB	CSO	C/N	Hum	P/V
Conventional	−52 dB	−55 dB*	−47 dB	>1%	3.6 dB
Feedforward	−57 dB	>−72 dB	−55 dB	>1%	3.9 dB

*Note: Our lab tests show that this level of distortion will be visible with CW carriers. The system was specified before the effects of CSO were known and this parameter was not considered. During field testing this CSO of -55 dB was discovered. Since the system was operating only 26 channels at that time, we combined 26 CW carriers (at the high end) along with the 26 normal signals. No distortion could be seen even after raising the CW signals 3 dB above their normal operating levels. This led to testing just how much modulation reduced the effective distortion products, which in turn allowed the level increases that this article discusses.

For the data gathered with CW carriers, the crash point of +46 dBmV and 6 dB tilt could be restated as +49 dBmV and a 12 dB tilt. If the system is going to carry programming to people, rather than pass tests in a lab, an additional 5 dB of output level would seem reasonable in terms of avoiding saturation.

Building to save

Originally, we designed several UACC systems to run +54 dBmV out of every bridger and line extender with 52 channels, but we eventually built these systems at +52 dBmV and a 12 dB slope. Because the published distortion specs after 20 trunks (+43 dBmV and 6 dB slope), one bridger and two line extenders at the +52 dBmV exceeded our target of a −51 dB composite triple beat and −66 dB composite second order (CSO), we increased the line extender cascade allowance to three in one case. This calculated to produce the −51 dB CTB and was still better than the −66 dB CSO.

Tests run on this system by the turnkey contractor and witnessed by myself confirm that the worst CTB was −57 dB. The worst CSO was >−72 dB (the noise limit of our test set) when the tests were run with CW carriers. In addition, the system remained well behaved (within our ability to measure) past a 2 dB increase in levels, still with the CW carriers. The system carrier-to-noise (note the high trunk levels) tested to be in excess of 55 dB and calculated to be 53 dB.

While it is not completely understood why the system remained well-behaved with CW carriers at these levels, the fact is that it did. And since there are approximately 500 miles of system in several cities operating with this efficiency, it is assumed that it will continue to run as tested.

The system physical characteristics outlined below and compared with a conventional electronics system designed at the same time by the same designer can be used to calculate what other operators might save in terms of dollars. For United Artists Cablesystems, the savings over conventional electronics was about $250 per mile up front and about an 8 percent savings in power consumption. If the equipment reliability is equal, the feedforward system, because it uses less amplifiers, will be available about 73 percent more often than the conventional system. The results presented in Table 6 seem to indicate that all factors should be considered before deciding that supertrunks are the only application for feedforward.

The sub knows

Properly designed feedforward equipment along with efficient designs can produce working and cost-effective cable systems. Unsolicited customer compliments indicate that the additional performance is noticed and appreciated. To paraphrase Mark Twain, the reports of feedforward's demise are greatly exaggerated. ■

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Taking the baseband approach

By Michael E. Long
Manager, International CATV, Zenith Electronics Corp

The recent advances in cable TV home terminal design have resulted from many factors. Increased channel capacity, consumer demands for new programming and features, supplier competition, and continual additions of auxiliary services, all have influenced new developments. The selection of subscriber terminals should not be considered as an isolated decision, but must be studied as part of an integrated system design including the consumer as end user. Careful study of consumer needs and anticipated services is necessary to allow for system adaptability to future advances.

The evolution of cable TV/pay TV subscriber terminals represents continuing industry development to satisfy subscriber needs for improved services and features. In order to effectively plan for the long term, initial hardware decisions in the CATV system design must provide for flexibility. The baseband approach of home terminal design can provide for future adaptability, which can ultimately lead to a communication system having an optimum balance between consumer utility and operating economics.

System choices

The two major choices for subscriber interface in CATV system design are off-premise and in-home terminals. Either terminal type can be configured into tree-and-branch or star system architectures. The main advantage that off-premise converters or switching systems have is that subscription TV signal security may be obtained without the need for scrambling. However, some types of off-premise systems limit the bandwidth provided to each home. These systems only deliver one or a restricted number of program channels at any time to a household, limiting the subscriber use of multiple TV receivers and VCRs.

Additionally, the economic aspects of off-premise systems should be considered. Terminal capability must be provided for each home passed, whether connected or not and including margin for expansion, affecting the actual cost per subscriber. The terminals must be more rugged to withstand environmental effects, and the cost of powering these terminals also may need to be absorbed by the cable operator. In-home terminals normally are powered by the subscriber.

The in-home terminal approach can provide the flexibility required for long-term service expansion opportunities. With this approach the entire CATV spectrum is available to each subscriber, allowing for unlimited multichannel use of multiple TV receivers, VCRs and future supplemental services. Home terminal equipment need only be provided for those connected homes actually subscribing to premium services, reducing the effective cost per subscriber. Addressability allows for low-cost service level changes and provides an individual communication link for present or future purposes.

Since in-home terminal systems deliver the full CATV spectrum to the consumer, premium services must be protected by the use of some type of signal security. Video scrambling systems for this purpose can generally be divided into two technology groups: RF and baseband. RF scrambling systems, although initially lowest in cost, are also the least flexible and secure due to the simplicity of the technique. Additionally, RF systems usually require out-of-band addressability, absorbing valuable CATV spectrum and reducing data security.

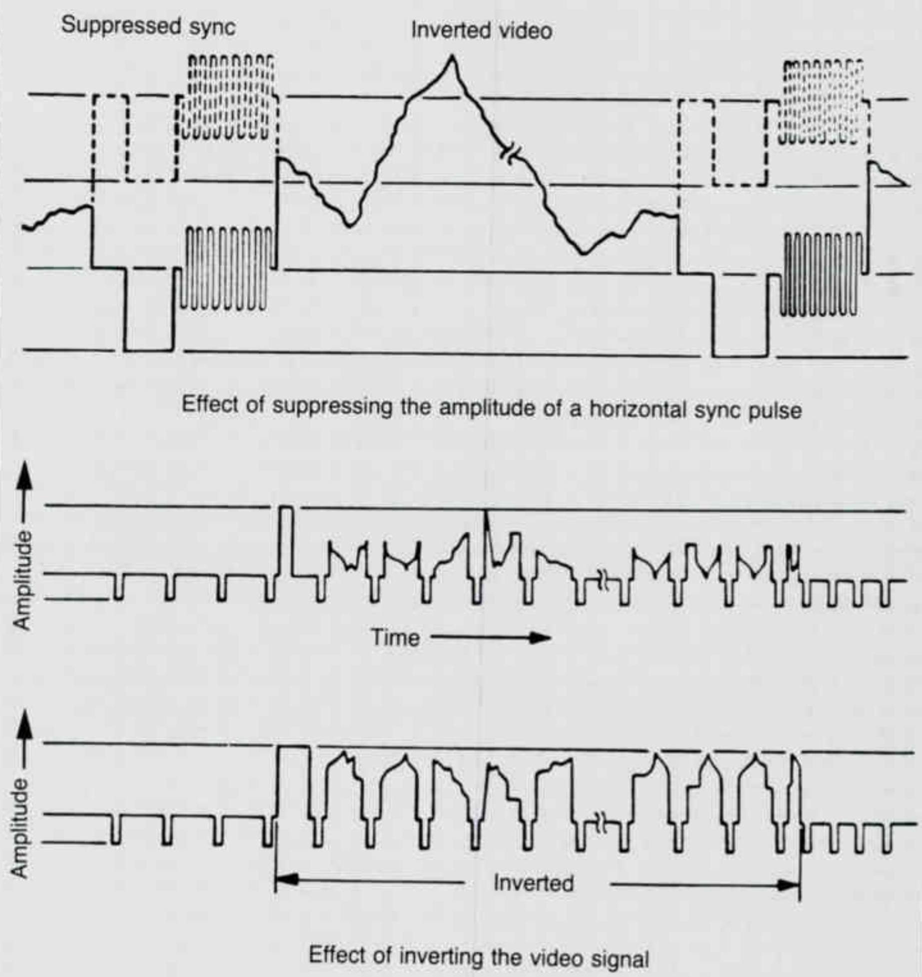
Baseband scrambling techniques are more secure than RF systems due to the inherent complexity of the decoding process. In-band addressability can be included in such systems, conserving valuable channel space and providing an additional level of data security. Baseband scrambling ultimately could allow the most utility, flexibility and lowest cost when integrated with the home TV receiver and other consumer electronic products.

Security

The simplest way to scramble a TV signal so that an unviewable TV picture is delivered is to obscure the signal's horizontal synchronization pulse at the start of each video line. All major scrambling systems, whether RF or baseband, can achieve this effect in one way or another. The result is horizontal picture tearing as the TV receiver searches the video for anything resembling synchronization pulses to lock onto.

RF systems typically superimpose sine wave or square wave signals over the visual RF transmission in such a way that the video synchronization pulses detected by the TV receiver are suppressed into the normal video region. Restoration timing signals usually are co-transmitted as amplitude modulation on the

Figure 1: Baseband video scrambling



channel's aural carrier. These systems have two liabilities. First, the simplicity makes them easy to defeat. Second, because the TV horizontal circuitry is looking for maximum transmitted signals, the TV receiver can "lock in" a viewable picture at times. This can occur especially if the average picture level of the video is near white level. Additionally, newer TV sets with more sophisticated synchronization circuitry may provide viewable video more often than older sets.

Baseband systems have better access to the elements of the video signal itself, enabling more complex scrambling to overcome some of the deficiencies of RF systems (see Figure 1). With some baseband systems, instead of only suppressing horizontal synchronization pulses, the video portion of the signal also can be inverted in a controlled manner. By controlled video inversion, the average picture level of the video can be maintained below the level of the suppressed synchronization pulses. The result is that the TV receiver consistently tries to lock horizontally to the variable signals in the active video portion of the horizontal line (see Figure 2).

Many systems utilize a constant scrambling technique such that the same type of signal modification occurs consistently on every line of every video frame. There is never a deviation to confuse a potential illegal decoder. A more secure choice would be a baseband system that can be selectively configured as a non-constant scrambler. The encoder will randomly, every one or two seconds, fail to depress the synchronization pulses for a video frame. This technique can prove to be very frustrating for someone attempting to defeat the system, especially since no decoding or timing information is co-transmitted with the signal.

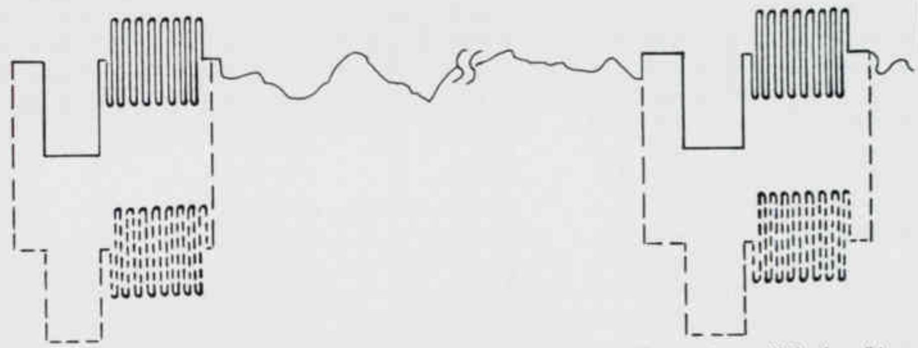
In addition to sync suppression in a fixed or random manner, the active video can be inverted in a fixed or random manner independent of the sync pulse scrambling function. Decoding information, concerning the state of video inversion, is securely encrypted in the digital addressing data transmitted in the video vertical blanking interval (VBI).

The baseband decoder is designed to be flexible and adaptive to this random scrambling environment. A custom proprietary LSI integrated circuit acts to reinsert synchronization impulses in the video only when the pulse has been suppressed by the encoder. Additionally, the circuit decrypts the VBI addressing data to control the inverted or non-inverted state of the active video. Descrambling is permitted only if the selected channel's VBI program tag matches the previously addressed authorization level in the decoder IC's internal memory. Thus, the use of a baseband approach can help to provide improved premium signal security for the in-home CATV terminal.

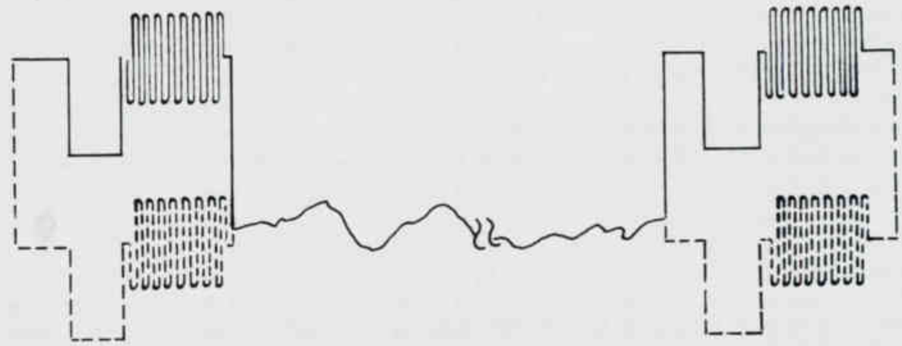
Addressability

Since RF systems do not demodulate the selected channel, the decoder circuitry has no access to high bandwidth in-band signal components that could be used for data trans-

Figure 2

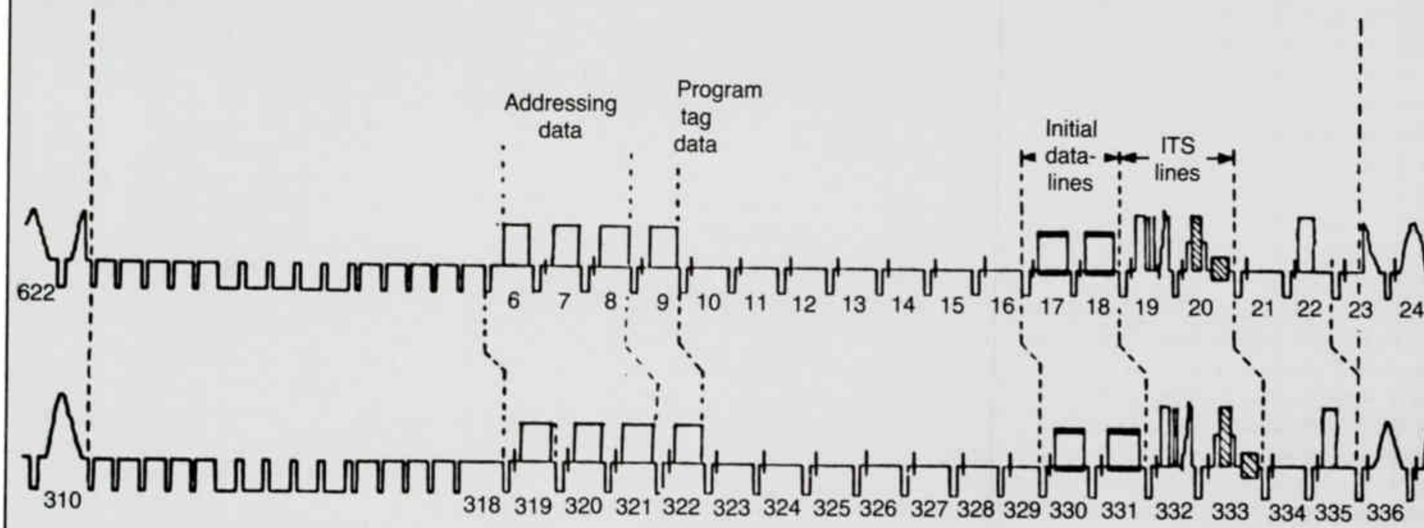


Using suppressed sync with white average picture level (APL), TV receiver will "lock up" to syncs



Inverting video for APL black ensures that TV receiver will not "lock up" to syncs

Figure 3: In-band VBI addressing



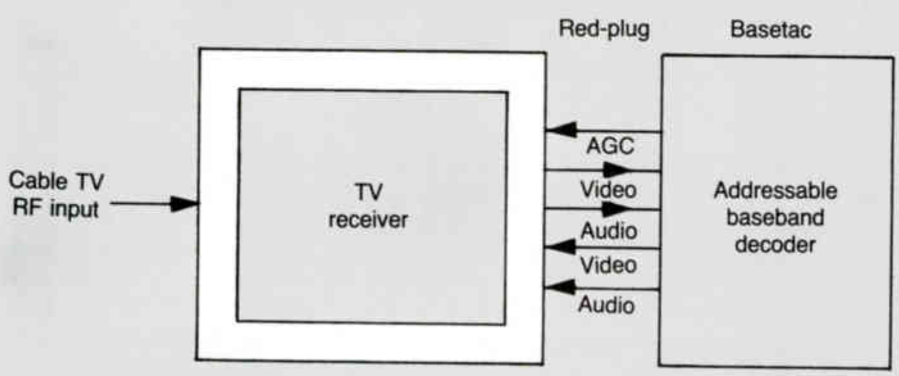
mission. This being the case, addressing data either is transmitted along with program tagging and decoding information as aural carrier amplitude modulation or is transmitted in an out-of-band data channel. Each method requires a separate data receiver in the home terminal and can either cause undesired audio by-products or use up valuable CATV RF spectrum.

The baseband approach can allow for integral low-cost in-band addressability. Since the selected channel is always demodulated, the decoder circuitry has access to data that can be transmitted on unused lines in the vertical blanking interval (see Figure 3). No separate data receiver is necessary, and neither the channel sound carrier nor the CATV spectrum is affected. The transmitted data is more secure since the channel video must be demodulated and nearly descrambled in order to receive data. The data channel cannot be "trapped out," as with out-of-band addressing systems, eliminating the requirement of automatic decoder de-authorization in the event of not being addressed. Such systems requiring this non-addressed time-out function could be rendered totally inoperable resulting from a headend addressing computer breakdown. In-band addressability also allows for compatibility with off-air pay TV approaches.

Consumer product compatibility

The baseband approach can allow optimized consumer utility and the lowest cost if home terminals and TV or VCR designs are complementary or integrated (see Figure 4). Baseband technology is suited for this approach since baseband video is the lowest user uncontrolled common denominator in consumer TV/VCR receiver design. Both TVs and VCRs were designed to provide easy-to-use features and convenient channel selection capabilities for the consumer. These features can suddenly become unusable through the addition of a set-top CATV converter/decoder, or an off-premise system only delivering a single channel to the home receiver. With baseband scrambling technology, a TV or VCR can be designed to interface with a low-cost external or internal addressable baseband descrambler. This approach returns the channel tuning function and other features to the consumer's TV product where they are the most effective.

Figure 4: Consumer product compatibility



Increased features, flexibility

In some instances, the use of set-top converter decoders can be of benefit. Many home TV receivers may not include the popular consumer features most desired. By the addition of a set-top converter, the TV receiver can become upgraded to one that has the latest conveniences, including IR remote control, digital channel display, cable-band tuning, etc. The baseband converter, in particular, easily can add features such as remote volume control/muting, video/audio outputs for VCRs, and provide video/audio and data access to auxiliary equipment for teletext, stereo or interactive services.

The baseband in-home CATV home terminal also can become the central element for interfacing new supplemental services to the CATV subscriber equipment. With access to the demodulated video and audio and in-band data, which the baseband approach provides, optional accessory devices connected to the baseband home terminal can inexpensively upgrade services as they become available or desired. Two-way interactivity, for example, can be implemented at reasonable per-subscriber cost through the use of the secure in-band VBI data as the downstream communication link.

As well, feature upgrades such as stereo audio programming and teletext can be provided easily for on baseband home terminals. The free access to the demodulated video that baseband equipment provides can allow for inexpensive future compatibility with services such as addressable full-field teletext and computer software downloading. ■

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GENERAL INSTRUMENT

Table 1: K factor guide*

	Propagation conditions				
	Perfect	**Ideal**	**Average**	**Difficult**	**Bad**
Weather	Standard atmosphere	No surface layers or fog	Substandard, light fog	Surface layers, ground fog	Fog, moisture over water
Typical	Temperate zone, no fog, no ducting, good atmospheric mix day and night	Dry, mountainous, no fog	Flat, temperate, some fog	Coastal	Coastal, water, tropical
K factor	1.33	1-1.33	0.66-1.0	0.66-0.5	0.5-0.4

*For 99.9-99.99 path reliability.

Program for antenna heights on an LOS microwave link

By Lawrence Lockwood
President, TeleResources Research & Development

In addition to the straightforward geometrical evaluations for a line of sight (LOS) microwave link, other factors must be considered. They are refraction of the signal, obstacles, and Fresnel zones.

Refraction

Radio waves traveling through the atmosphere do not follow true straight lines; they are refracted or bent. Under normal propagation conditions, the refractive index of the atmosphere decreases with height so that the radio wave rays travel more slowly near the ground than at higher altitudes. This variation in velocity with height results in bending (refraction) of the radio wave rays. Uniform bending may be represented by a straight line propagation but with the radius of the Earth modified so that the relative curvature between the ray and the Earth remains unchanged. The new radius of the Earth is known as the effective Earth radius, and the ratio of the effective Earth radius to true Earth radius is usually denoted by K where $K = a'/a$ (see Figure 1). The average value of K in temperate climates is often taken as $4/3 = 1.33$. The radio refractive index of the atmosphere is $n = 1 + N \times 10^{-6}$ where N (the refractivity) is:

$$N = \frac{77.6}{T}\left(P + \frac{4.8W_p}{T}\right)$$

and
P is atmospheric pressure in millibars
W_p is water vapor pressure in millibars
and T is absolute temperature in ° Kelvin.

Therefore, due to these variables affecting the index of refraction, the value of K will vary and values from about 0.4 to well over 4/3 are to be expected. The K factor can be determined by one of the following methods.

1) Refer to a sea level refractivity profile chart (see Figure 2). Select the appropriate sea level refractivity number for the area of interest. Apply the refractivity value to Figure 3, with the mid-path elevation and refractivity number. Read off the corresponding K factor.

2) Lacking a refractivity contour chart for the area, calculate using three K factors: 1.33, 1.0 and 0.5. A later field survey will help to decide which factor is valid. For instance, in coastal regions, over-water paths and damp regions, assume the lowest value. In most dry regions (non-desert) the so called normal value (1.33) may be assumed. Table 1 will help as a guide to determining the K factor.

In the program, K is 4/3 but a provision is made for using other values of K as required. From Figure 1:

$$(a')^2 + d_1^2 = (a' + h_T)^2$$
$$d_1^2 + 2a'h_T + h_T^2$$

but since $a' >> h_T$

$$d_1^2 \simeq 2a'h_T = 2Kah_T$$
$$d_2^2 \simeq 2a'h_R = 2Kah_R$$

Putting a, d_1, d_2 in miles and h_T and h_R in feet,

$$d_1 = (2Kah_T/5{,}280)^{1/2}$$

taking a = 3,960 miles

$$\text{then } d_1 = (3Kh_T/2)^{1/2}$$

Thus:

$$h_T = 2d_1^2/3K$$
$$h_R = 2d_2^2/3K$$

A nomogram relating path distance and transmitter and receiver antenna heights for a smooth spherical Earth (with K taken as 4/3) is shown in Figure 4. The true distance between transmitter and receiver lies in the plane of the great circle between them; however, for distances less than 50 miles the plane geometry treatment used here may be used with an error of approximately 0.5 percent. Referring to Figure 1, if the true ground distance between h_T and the horizon is 50 miles and the Earth's radius is 3,960 miles, then:

$$\Theta = 50/3{,}960 = .0126262626 \text{ radians}$$
$$= .7234315595 \text{ degrees}$$

since $\tan\Theta = d_1/3{,}960$

$$d_1 = 3{,}960\tan\Theta = 50.00265721 \text{ miles}$$

or approximately 0.5 percent error.

Obstacles

Until now, the transmission path has been treated as though it were on a smooth spherical Earth with no obstacles in its way. Figure 1 is modified in Figure 5 to show an obstacle (hill, building, vegetation, etc.) of height b. For the calculations derived, b may be added to a', h_T or h_R yielding an error of less than 0.008 percent for path distances of less than 50 miles. As seen in Figure 5A, h_T is the transmitter height required for the path d_1 from the transmitter to point R. If an obstacle of height b is placed at point R, the percentage error of substituting the value of b for O_H is derived as follows:

since $\cos\Theta = b/O_H$

$$O_H = b/\cos\Theta$$

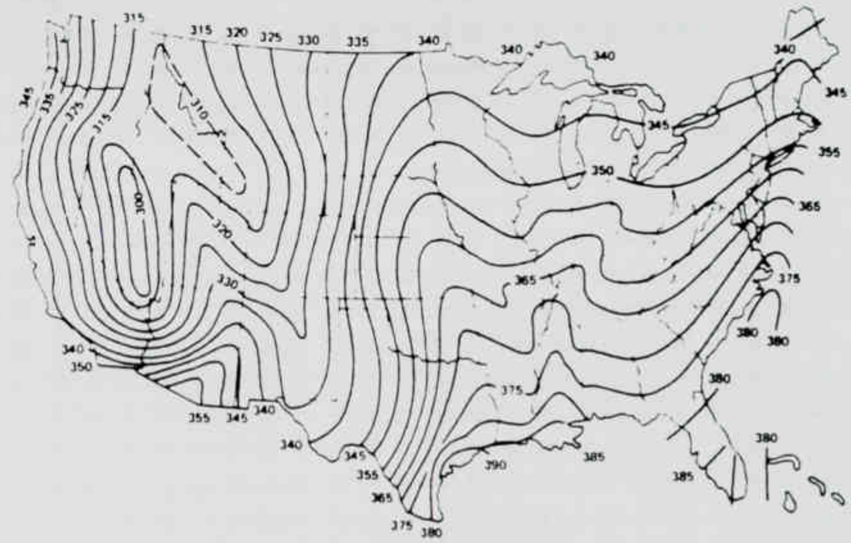
and taking an obstacle height of b = 1,750 feet, then the error in substituting b for O_H is:

$$O_H - b = .13950396 \text{ feet}$$
$$= 1.6740475 \text{ inches}$$

or an error of less than 0.008 percent.

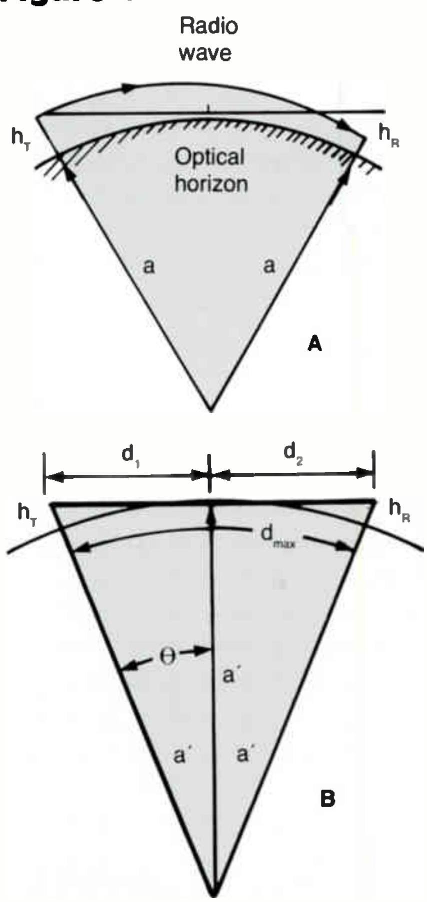
'Radio waves traveling through the atmosphere do not follow true straight lines; they are refracted or bent'

Figure 2



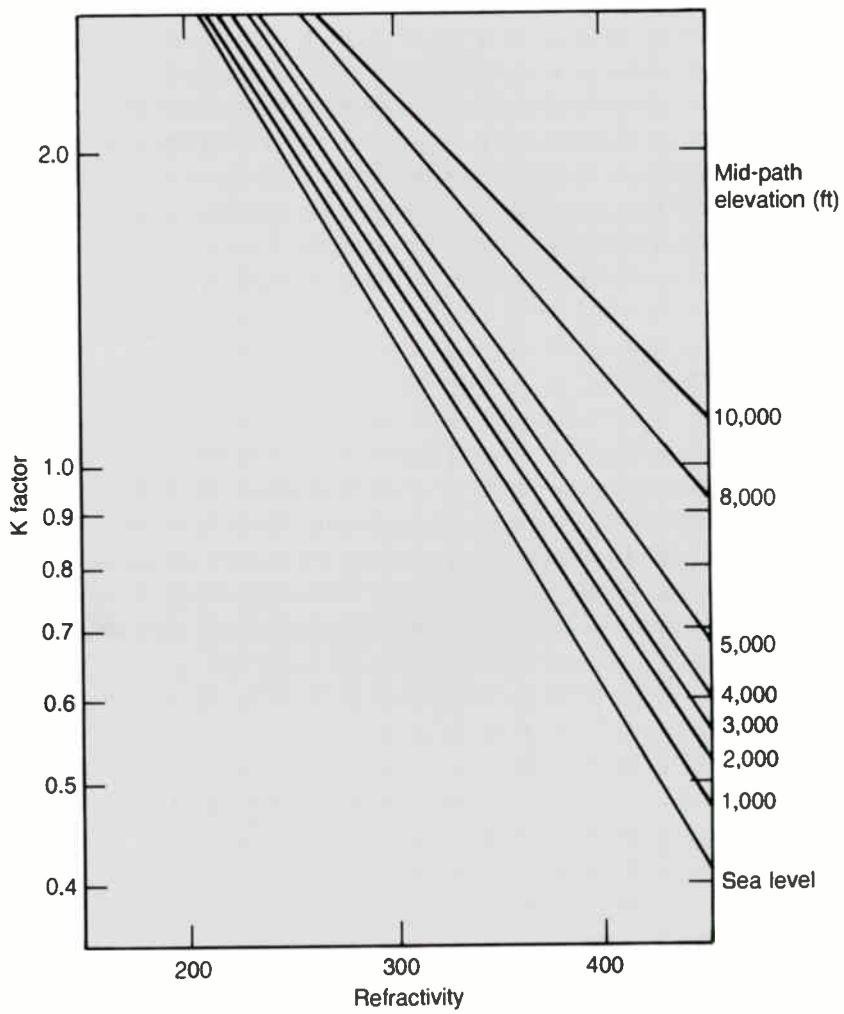
Sea level refractivity index for the continental United States—maximum for worst month (August).

Figure 1



Part A shows curvature of ray path over Earth of radius *a* resulting from change of the refractive index of air; B illustrates the equivalent straight-line ray path for effective Earth's radius *a´*.

Figure 3: K factor scaled for mid-path elevation above mean sea level



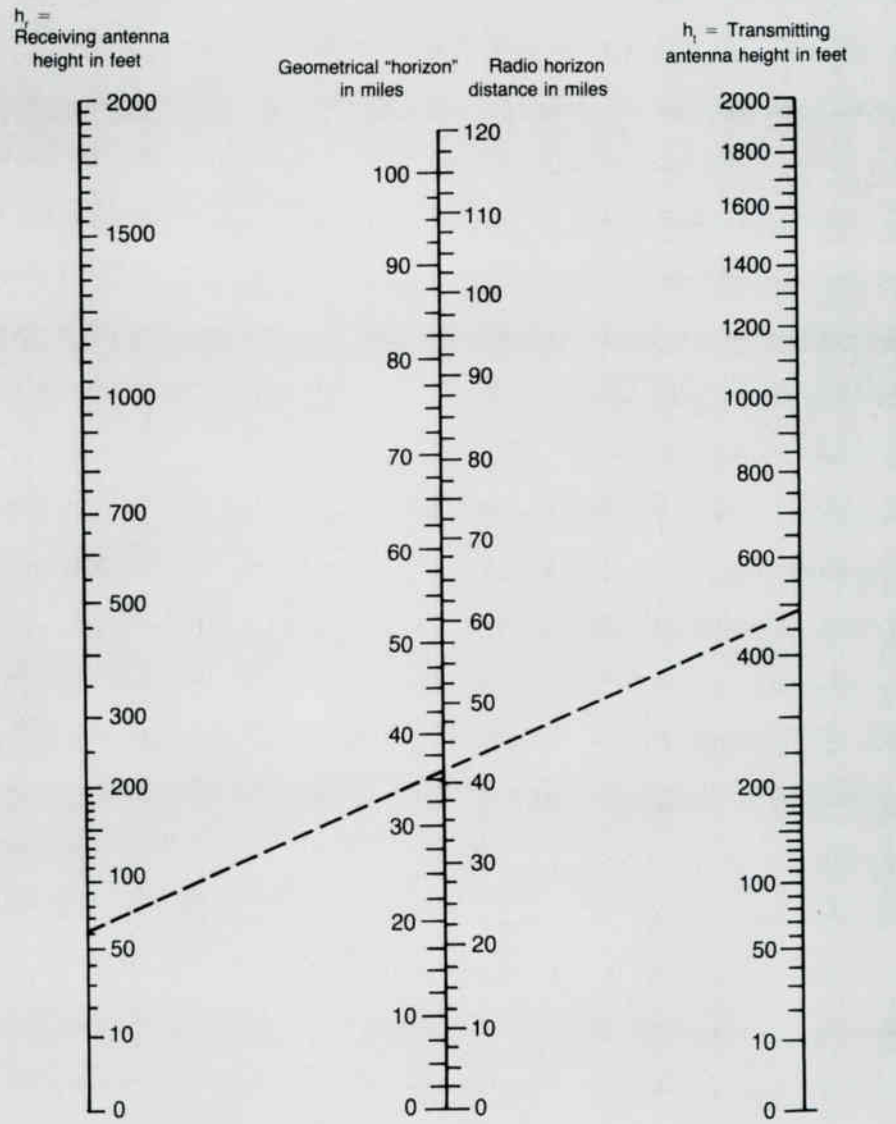
Fresnel zones

The Fresnel-Kirchoff theory originally was developed to account for the diffraction of light transmitted through apertures of various shapes and sizes. It may be applied to radio propagation as well. Consider a transparent screen between a distant transmitter T and a receiver R with the distance from screen to transmitter being at least 10 times the distance from screen to receiver and with the plane of the screen perpendicular to the direction T – R (see Figure 6). Concentric circles may be drawn on this screen, with the centers at the point where the line T – R intersects the screen at O, the radius of the first circle being such that the difference in length between the path O – R and the path from the circumference of this circle to R is 1/2 wavelength (λ). The radii of the other circles are such that the corresponding path length differences are integral multiples of $\lambda/2$. From Figure 6:

$$r^2 + d^2 = (d + \lambda/2)^2$$
$$r^2 + (d + \lambda/2)^2 - d^2$$
$$r = (\lambda d + \lambda^2/4)^{1/2}$$
since $\lambda^2/4 << d$
$$r \simeq (\lambda d)^{1/2}$$

Therefore the radius of the first circle is $(d\lambda)^{1/2}$ and the radius of the second circle is $(2d\lambda)^{1/2}$, of the third $(3d\lambda)^{1/2}$, etc. The area within the first circle is called the first Fresnel zone, and the other ring-shaped areas are the second, third, etc., Fresnel zones. The fields from the odd-numbered zones are in phase at R, and the fields from the even-numbered zones are 180 degrees out of phase at R with the odd-numbered zones. If the distance from the screen to the transmitter is d_1 and from the

Figure 4



Nomogram giving radio-horizon distance in miles on a smooth spherical Earth when h_r and h_t are known. Example: Height of receiving antenna 60 feet; height of transmitting antenna 500 feet; maximum radio-path length = 41.5 miles (K = 1.33).

Figure 5

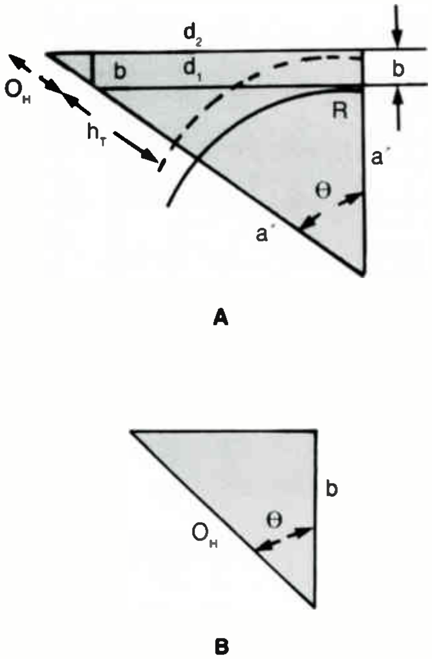
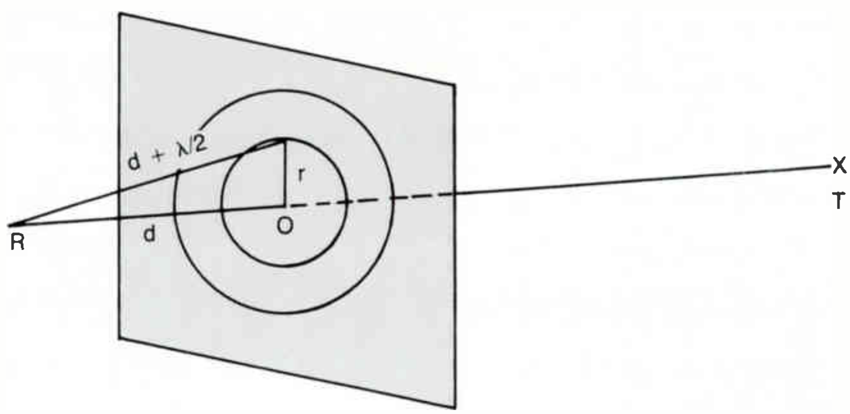


Figure 6



screen to the receiver is d_2, then the general expression for the radius of the n^{th} Fresnel zone is $(n\lambda[(d_1 \times d_2)/(d_1 + d_2)])^{1/2}$. The radius of the first Fresnel zone is $r = (\lambda d_1 d_2/D)^{1/2}$, where $D = d_1 + d_2$ and all the quantities are expressed in the same units.

Since $\lambda = C/F \times 10^6$
where C = velocity of light
= 186,000 miles/second
F = frequency in MHz

then

$$r = \left[\frac{186{,}000}{F \times 10^6} \left(\frac{d_1 d_2}{D} \right) \right]^{1/2}$$

where all distance units are in miles and F is MHz. To get r in feet:

where all distance units are in miles and F is MHz. To get r in feet:

$$r = \left[\frac{186{,}000 \times 5{,}280}{F \times 10^6} \left(\frac{d_1 d_2 \times 5{,}280}{D} \right) \right]^{1/2}$$

$$= 2{,}277(d_1 d_2/FD)^{1/2}$$

Optimum clearance of an obstacle (or the horizon in the absence of an obstacle) is generally accepted as 0.6 of the first Fresnel zone radius. Since the value of the Fresnel zone clearance is dependent on the index of refraction some are using as a rule of thumb, namely, where K = 2/3, at least 0.3 Fresnel zone clearance and 1.0 Fresnel zone clearance be allowed when K = 4/3, whichever is greater. At points near the ends of a path, Fresnel zone clearances should be at least 20 feet.

The value of 0.6 for the Fresnel zone clearance factor is in the program but, as in the case of K, other values may be used as required. The values of distances and altitudes for use in the following program may be obtained from a topographical map of the area under consideration.

Figure 7: A generalized diagram of LOS with no obstacles (NOBS)

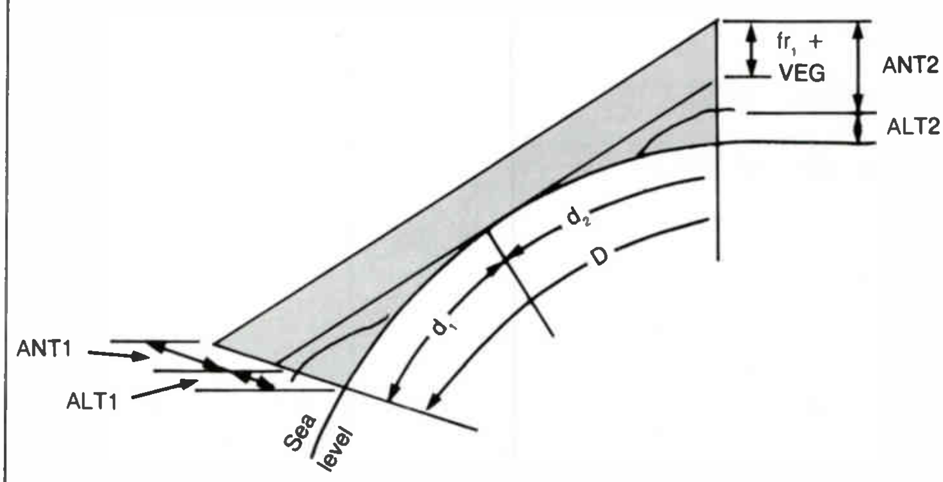
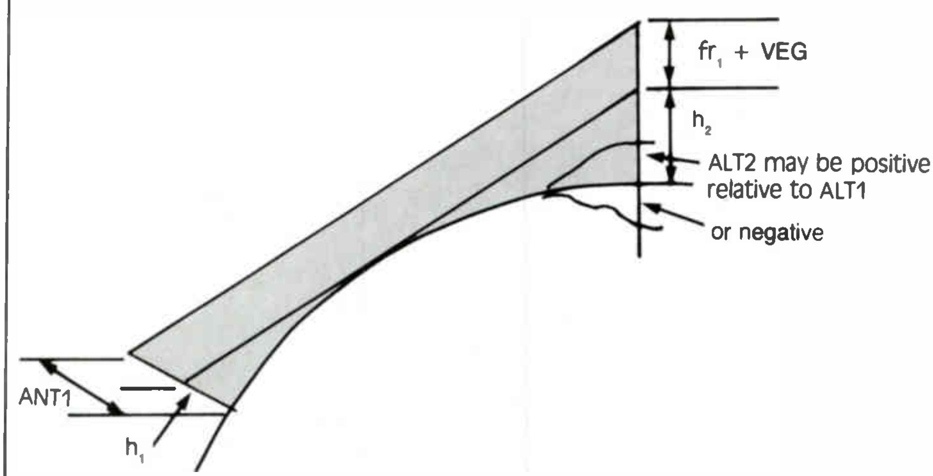


Figure 8: Simplified Figure 7 with ALT1 taken as at radius of Earth



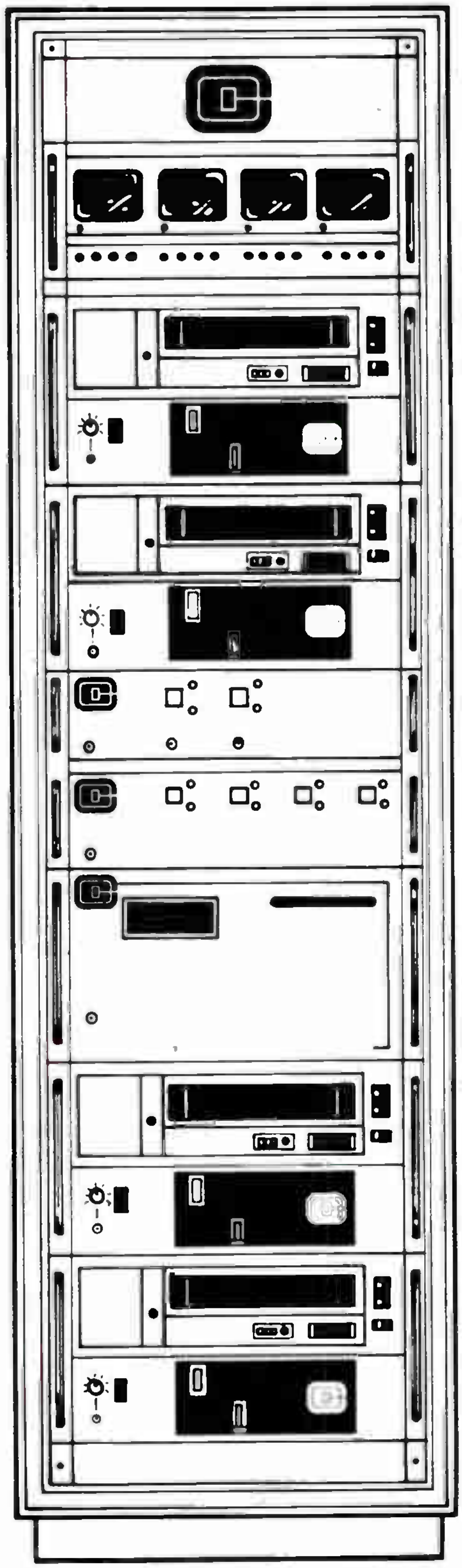


Figure 9: Flow chart depicting LOS microwave link with no obstacles (NOBS)

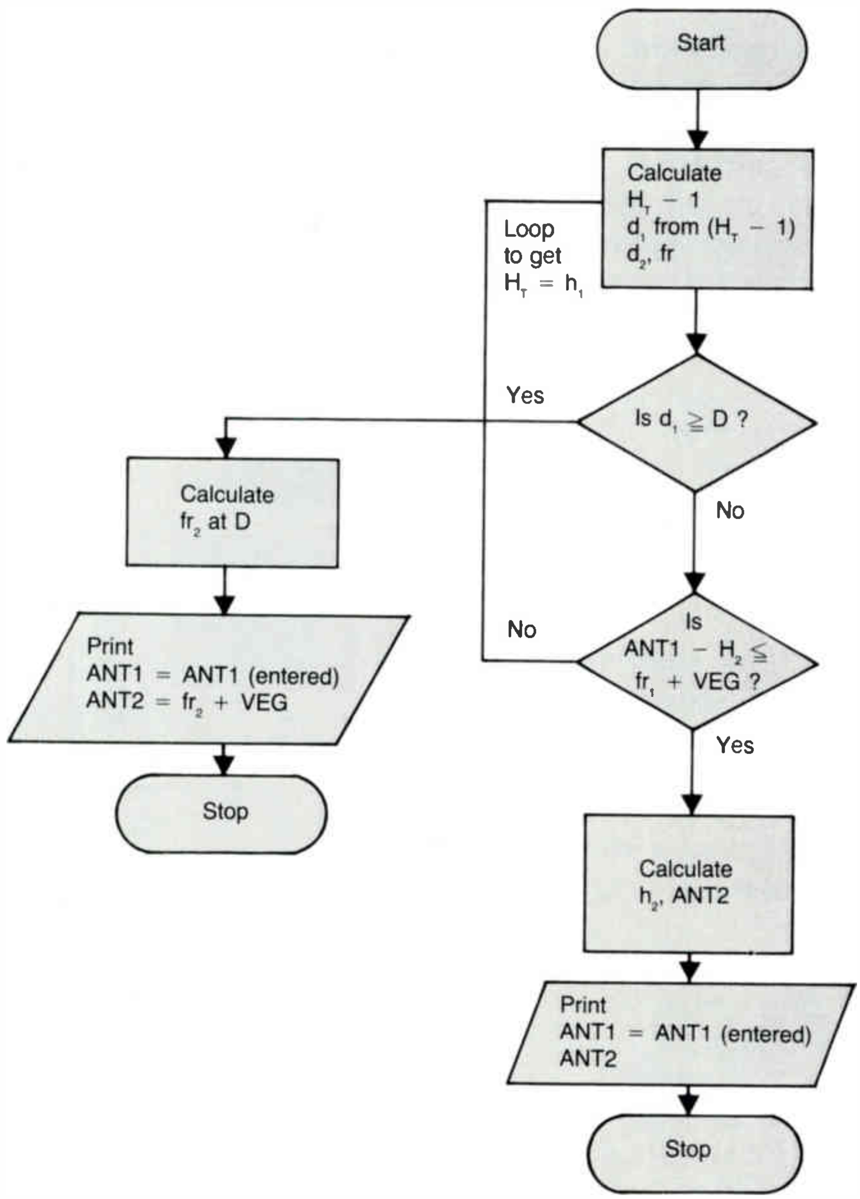
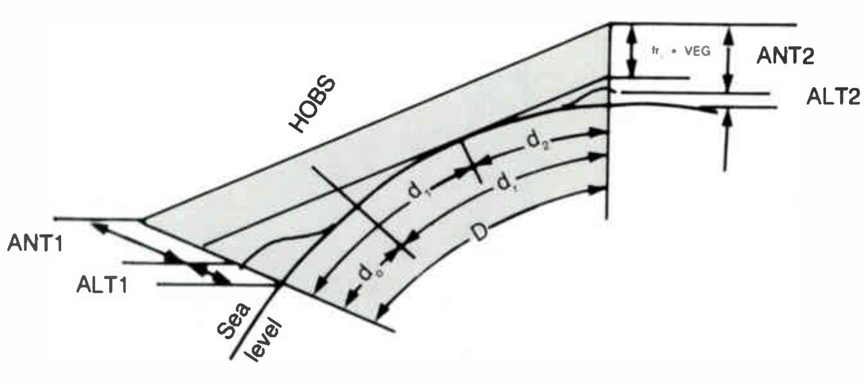


Figure 10: A generalized diagram of LOS with an obstacle (WOBS)



Fading, path attenuation and S/N

In all but very short microwave links, there is some fading of the signal. The principal cause of fading is the fact that at microwave frequencies there is a great deal of absorption and scattering from moisture and precipitation. The amount of fading that will occur over any particular path can be determined only by actual experience. Designers usually specify the fading along a path in statistical terms. If a system has a fading probability of 0.1 percent, the signals will be unusable only about nine hours per year. Reliable systems are completely out of service for a total of less than one hour a year as a result of fading. The equation for the signal power at the terminals of the receiving antenna is:

$$P_r = P_t + G_t + G_r - 20\log 4\pi D - 20\log F/300,$$

where:
P_t is the transmitter power in dBm
P_r is the power level in dBm at the receiving antenna
G_t is the gain of the transmitting antenna in dB
G_r is the gain of the receiving antenna in dB
D is the distance between the transmitting and receiving antennas.

Example: P_t = 1 watt (+30 dBm), both G_t and G_r = 40 dB, F = 12,825 MHz, D = 30,000 meters, and P_r = -34 dBm.

The minimum signal strength that can be allowed at the receiving end of a microwave link depends on the noise level at the input of the receiver. This noise power level in dBm is given by: $N = 10\log KTBN_f + 30$, where: N is the noise power level in dBm; K is Boltzmann's constant, 1.37×10^{-23} joule per kelvin; T is the temperature in kelvins (293 kelvins at room temperature); B is the bandwidth of the microwave receiver in hertz; and N_f is the noise factor of the receiver.

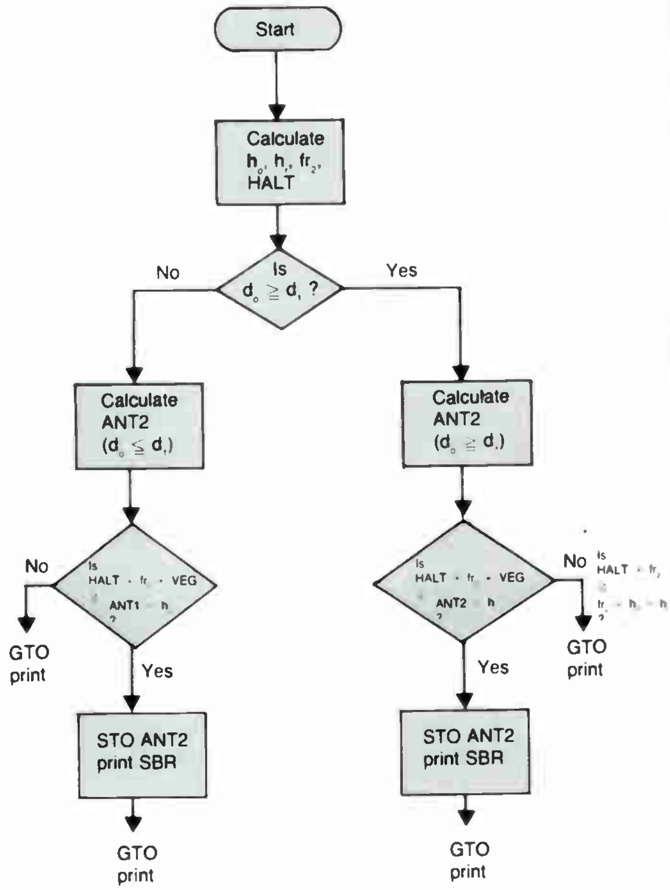
In a practical sense, where the bandwidth is about 15 MHz and the noise factor of the receiver is 12.6 (11 dB), the noise power in dBm works out to be -92.2 dBm. If this type of receiver were used with the link described above, the receiver signal-to-noise ratio would be: S/N = -34 − (-92.2) = 58.2 dB. This ratio is frequently called the a-m carrier-to-noise ratio.

There is often a great deal of confusion regarding signal-to-noise ratio in a complete receiving system. In addition to the bandwidth of the RF and IF sections, the bandwidth of the video amplifier following the detector must be taken into consideration to determine the overall signal-to-noise ratio.

Video signal-to-noise at output

In the preceding paragraphs, we computed the noise level in a receiver. The signal-to-noise ratio that we calculated was the ratio of the carrier to the root-mean-square (RMS) noise level in the receiver. What is more pertinent is the ratio of the video signal to the noise level at the output of the receiver. In order to

Figure 11: Flow chart depicting LOS microwave link with an obstacle



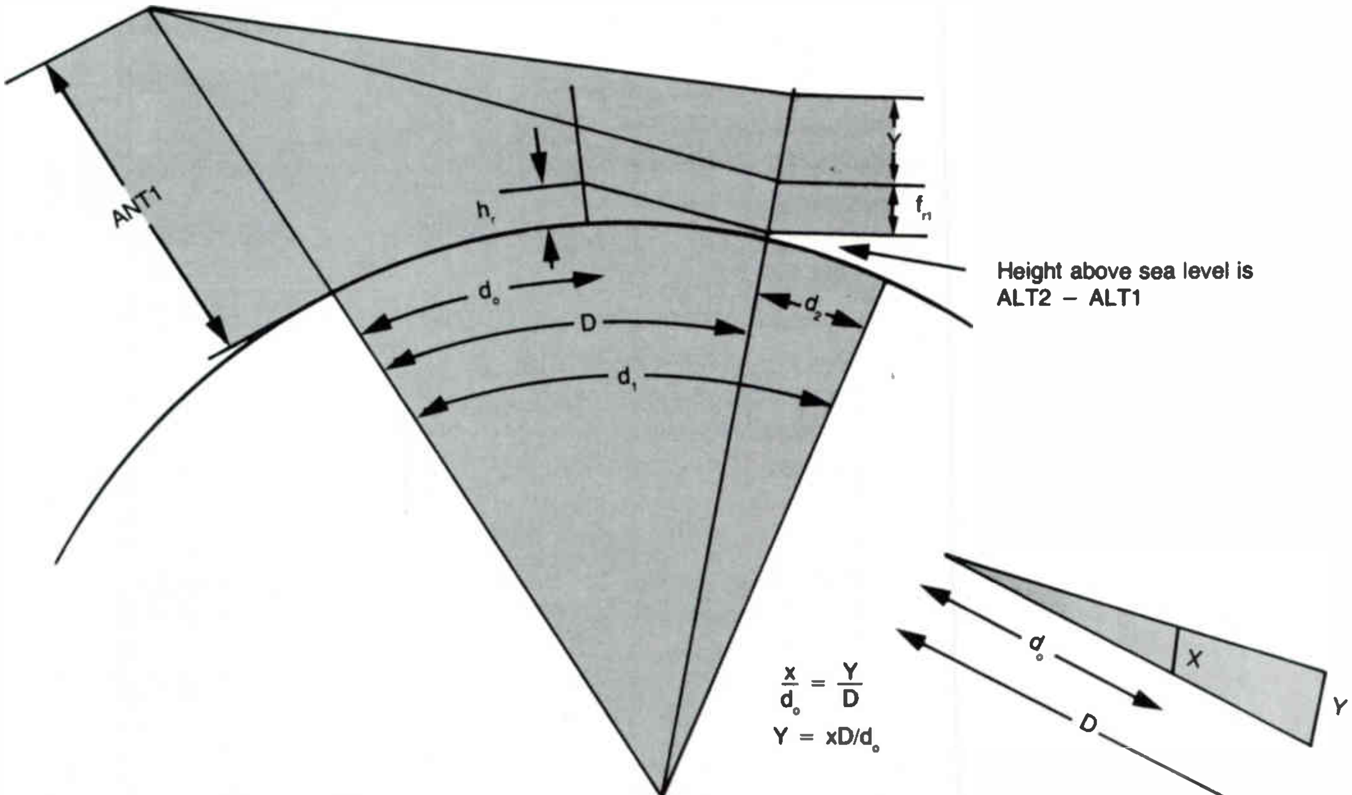
LOS program output

This is a typical example of the program output of an LOS path analysis. It does not, however, consider an intervening obstacle.

Frequency: 12825 MHz
K factor: 1.333333
Fresnel zone clearance factor: .6
Distance between sites: 18.64 miles
Altitude transmitter site above sea level: 0 feet
Altitude receiver site above sea level: 0 feet
Height of vegetation at receiving site: 0 feet
Height of transmitter antenna: 100 feet
Height of receiver antenna: 45.15656 feet
Transmitter power in dBm: 30
Gain of transmitting antenna in dB: 40
Gain of receiving antenna in dB: 40
Power level at receiving antenna in dBm: -34.14835
Noise factor of receiver: 12.6
Bandwidth of receiver in hertz: 1.5E+07
Noise power level in dBm: -91.19949
Carrier-to-noise ratio: C/N = 57.05115 dB
Video bandwidth in hertz: 4,500,000
Signal-to-noise ratio: S/N = 68.26964 dB

Figure 12

In programming the line of sight microwave problem in BASIC, a few additions and revisions were made. The most significant addition was providing the solution when there is an obstacle in the path and when the transmitting antenna is high enough in relation to the path length that $d_1 > D$. The conditions are shown here.



If $(HALT - h_r) > f_{r1} + (ALT2 - ALT1)$, then calculate ANT2 using x ELSE $ANT2 = (f_{r1} + VEG)$

$x = (HALT + fr_2) - (f_{r1} + ALT2 - ALT1) - h_r$

and since $Y = xd/d_o$

then $ANT2 = Y + f_{r1} = (HALT + f_{r2} - [f_{r1} + ALT2 - ALT1] - h_r) D/d_o + f_{r1}$

compute this figure, we must make a few additions to our equations. It is common to express the video signal-to-noise ratio in terms of the peak-to-peak video signal and RMS value of the noise. The peak-to-peak value of a video signal is about 9 dB greater than the RMS value. This means that we must add 9 dB to the carrier-to-noise ratio that we found earlier.

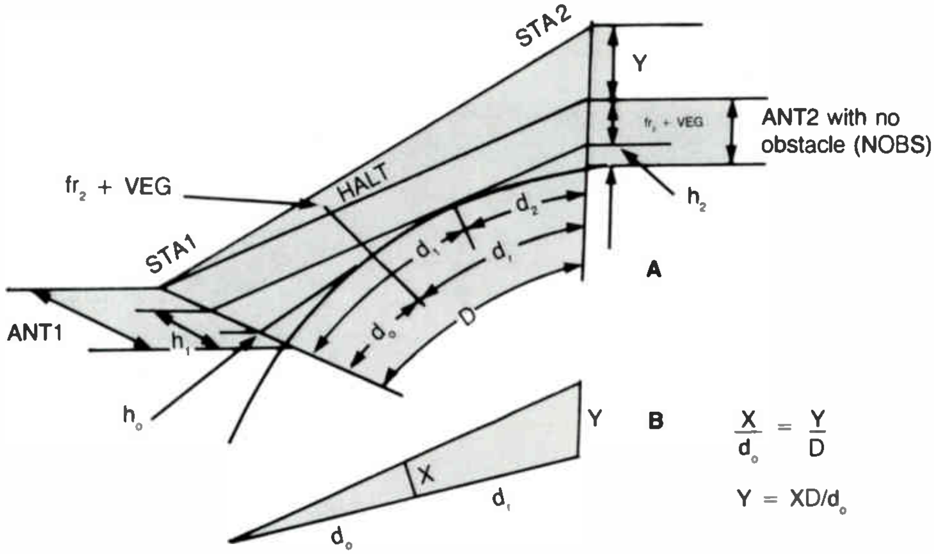
In addition, there is another factor that will improve the video signal-to-noise ratio. This is due to the fact that the bandwidth of the video stages of the receiver is much narrower than that of the RF stages. Actually, both bandwidths enter into the equation. The amount that the signal-to-noise ratio, expressed in decibels, must be increased due to the bandwidth considerations is $10\log B_{rf}/2B_v$, where B_{rf} is the bandwidth of the RF and IF portions of the receiver, and B_v is the bandwidth of the video portion after the detector. The video bandwidth is doubled because in the detection process, noise is taken from the portion of the spectrum containing the signal and also from what amounts to an image frequency.

The equation for the ratio of the peak-to-peak video signal to the RMS noise becomes: $S/N = C/N + 10\log B_{rf}/B_v + 9$, where C/N is the carrier-to-noise ratio found earlier. The last term of 9 dB results from converting RMS to peak-to-peak signal values, and the next to last term results from the bandwidth considerations.

In the preceding example, we found that the carrier-to-noise ratio of a particular receiver was 58.2 dB. In that example, we assumed

Figure 13

Again ALT1 taken as at radius of Earth (sea level). Under these conditions the height of the obstacle above radius becomes HOBS-ALT1, which we will call HALT.



$$X = (fr_2 + VEG + HALT) - (fr_1 + VEG) - (h_1 - h_0)$$
$$ANT2 = Y + fr_1 + VEG + h_2 + ALT1 - ALT2$$
If $d_0 \geqq d_1$
$$X = (fr_2 + VEG + HALT) - (fr_1 + VEG) - (h_2 - h_1)$$
$$ANT2 = Y + fr_1 + VEG + h_2 + ALT1 - ALT2$$

that the bandwidth of the RF portion of the receiver was 15 MHz. Let us further assume that the video bandwidth of the receiver is about 4.5 MHz. The equation for the signal-to-noise ratio now becomes: $S/N = 58.2 + 10\log 15/2(4.5) + 9 = 69.4$ dB. Thus, the actual signal-to-noise ratio at the output of the receiver is 69.4 dB.

These calculations were made assuming ideal conditions. It was assumed that the power of the transmitter is actually all radiated. In practice, there are losses in the transmission lines for both the transmitting and receiving antennas, and these losses must be taken into consideration. Also, fading (mentioned earlier) must be considered. Naturally, the better the signal-to-noise ratio under ideal conditions, the less likely it is that fading will seriously impair the signal quality.

In an FM receiver, once the threshold is passed there is an improvement from using FM as opposed to AM. The FM improvement factor is given by: $10\log 3(D/B_v)^2$, where B_v is the video bandwidth of the receiver, and D is the deviation of the FM transmitter.

In most TV microwave links, the deviation is not greater than the maximum video frequency to be transmitted, because the tradeoff between improvement of the noise performance is not worth the additional spectrum space required. Thus, the improvement factor will be about $10\log 3 = 4.8$ dB.

There is still another factor in FM transmission that may be used to improve the performance of the system, particularly with color signals. This is the addition of pre-emphasis at the transmitter and a corresponding amount of de-emphasis at the receiver. A pre-emphasis network is actually a high-pass filter that will artificially increase the level of the high-frequency portion of the video signal. Inasmuch as the color information is transmitted about 3.58 MHz above the bottom end of the spectrum of the video signal, the color information in the signal will be emphasized. At the output of the receiver, after the signal is no longer affected significantly by the noise in the system, the signal is passed through a low-pass filter that will restore the proper level of all components of the signal. The improvement commonly obtained by pre-emphasis and de-emphasis is about 2 dB.

Getting back to the example that we have been using, if the receiver used FM instead of AM, we would expect the signal-to-noise ratio to be about: $S/N = 69.4 + 4.8 + 2 = 76.2$ dB. This shows that a definite improvement can be obtained by using FM (providing the deviation is sufficient to pass the threshold).

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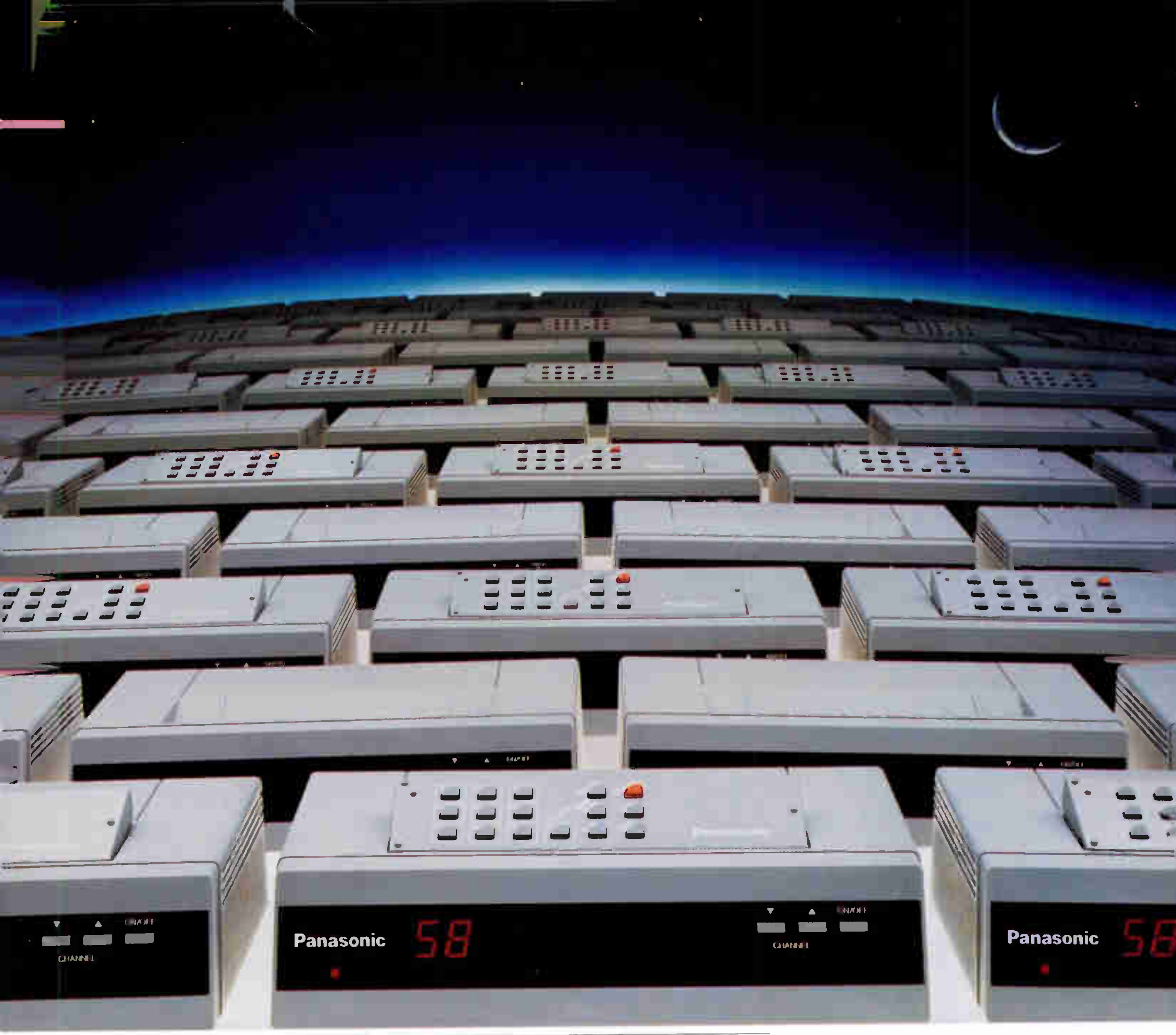
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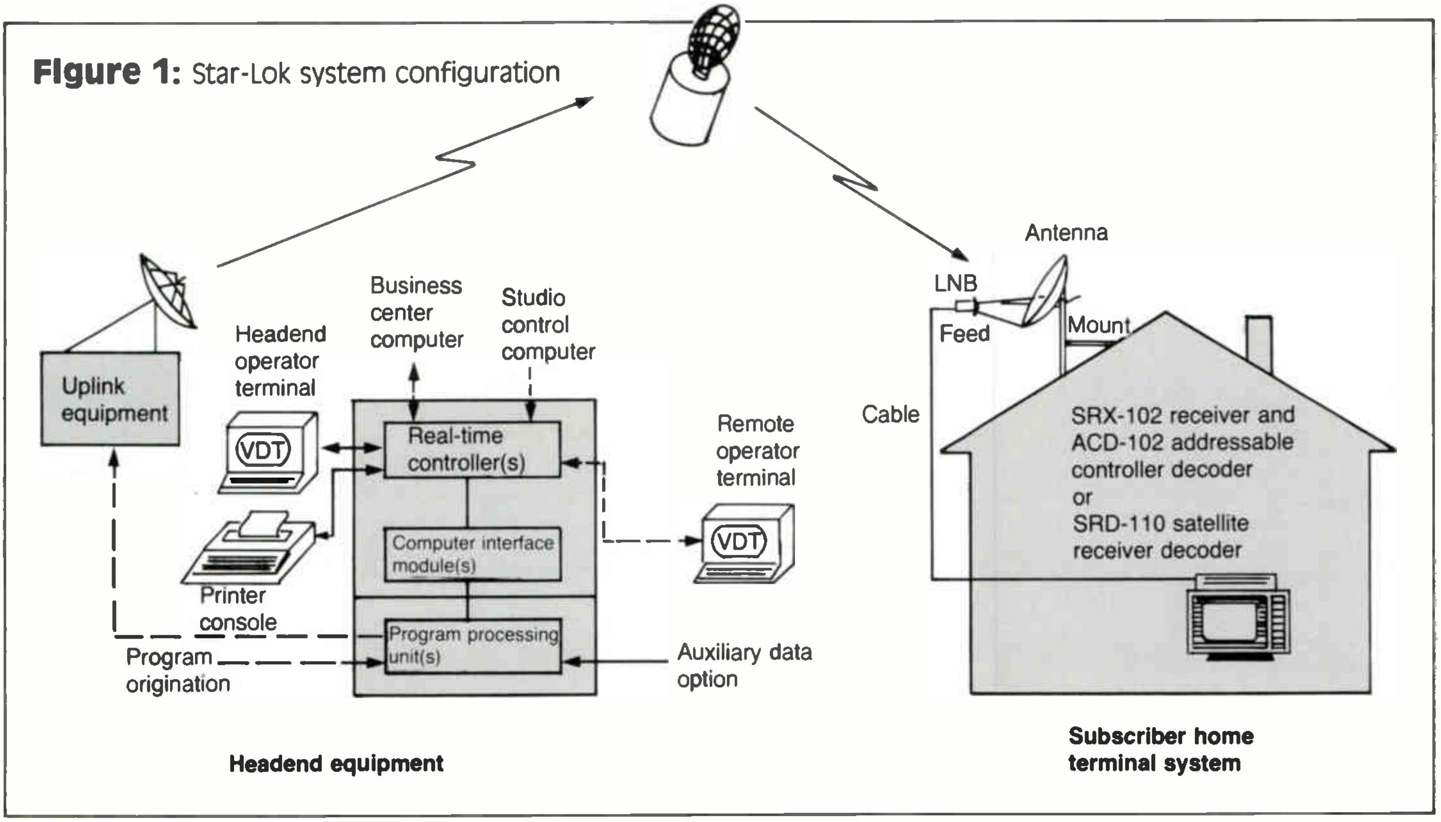

The Star-Lok scrambling system

This year scrambling was the top issue for discussion at the 1985 National Cable Television Association convention in Las Vegas, Nev., and it has emerged as one of the more salient issues for various segments of the communications industry. The race is on to come up with a standard scrambling system at the lowest cost, and there are now a number of satellite scrambling systems on the market today from which to choose. This article presents a basic overview of the Star-Lok scrambling system developed by General Instrument Corp.

By John McLellan
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Star-Lok is a highly secure, low-cost, addressable video-audio scrambling system designed for use in satellite DBS, teleconferencing and private video networks; and MMDS, SMATV and cable TV distribution systems. Before discussing the system's security mechanisms, it will be helpful to briefly describe its features, operations and signal formats.

System features and overview

This scrambling system has a number of standard features, including:

- Scrambled video based on a modified NTSC format, with audio, address and control data carried in the horizontal blanking interval (HBI).
- Two high-quality Dolby audio channels.
- Securely encrypted audio and control data.
- Forward error correction of audio and control data for extended operation at a low carrier-to-noise ratio (C/N).
- Individual addressing of up to 16 million subscribers.
- Thirty-two program authorization levels.
- Sixty-five thousand program tags.
- Eight-level parental control.
- Local area blackout for premium events.
- Address and control computer with interface to business and program control computer.
- Compatibility with existing NTSC studio equipment and transmission paths.
- Compatibility with standard VBI test signals and data transmission equipment.
- Optional remote operation from a business center or studio via standard telephone modems.

In addition to these standard features, the basic system is available with a number of optional enhancements including impulse pay-per-view (IPPV), auxiliary data service and downloading of on-screen text.

Figure 1 represents a simple block diagram of the Star-Lok system in a satellite application. Headend equipment for the scrambling system includes a program processing unit (PPU), a Dolby digital audio processing unit (DP-85) and a real-time controller (RTC), which is a computer that provides the address and control functions. The subscriber equipment consists of an adddressable controller-decoder unit (ACD), which performs the decryption and descrambling functions.

Signal formats

The Star-Lok headend accepts standard NTSC video, plus two 15 kHz audio signals from the program source. The PPU strips sync and color burst information from the video signal and uses this information to develop all system timing and clock signals.

Audio signals are digitized in the Dolby DP-85 unit then applied to the PPU. Here, audio data is encrypted, combined with encrypted data from the RTC computer, forward error corrected at a ⅔ rate and clocked into the HBI of the video signal. Instantaneous data rate in the HBI is 7.16 MBPS or twice the chrominance subcarrier frequency. The baseband output of the PPU is roofed off at 5.5 MHz. The waveform at the output of the PPU is illustrated in Figure 2.

The ACD accepts a non-de-emphasized baseband signal from the receiver, derives all internal timing signals from the HBI data stream run-in code, and if authorized for the program being received, reconstructs the scrambled video signal to provide a clamped NTSC video output. Audio data is decrypted and decoded to provide two high-quality 50 Hz to 15 kHz audio outputs. Video and audio ports also are provided for application to a TV remodulator.

When receiving a standard NTSC signal, the ACD reverts to a bypass configuration, which loops the video and audio signals through the ACD unprocessed. This feature allows the

ACD to operate in a mixed scrambled/clear transmission environment.

Error detection and correction

Star-Lok makes use of both forward error correction (FEC) and a 16-bit cyclic redundancy check (CRC) to enhance address and control data reliability at low C/N. The FEC is a ⅔ rate convolutional code chosen for good performance and low cost. Coding gain is 3 dB. Control data packets are transmitted several times and any packet failing the CRC is rejected by the ACD. As a result of these measures—error correction and error detection—the probability of an ACD accepting a corrupted message and responding incorrectly is very low.

Three-pronged security

As already indicated, there are three scrambling mechanisms a would-be pirate must defeat to descramble a Star-Lok signal:

1) Video is scrambled by video inversion on a scene-change basis and complete removal of line and frame sync pulses as well as the color burst.

2) Audio is securely encrypted by exclusive OR-ing raw audio data with a bit stream generated by a stream cipher derived from a proprietary key and initializing vector. The key itself is transmitted in encrypted form via the control data channel and is changed each program session. The initializing vector changes each video frame.

3) Address and control data are organized into blocks of 128 bits and encrypted using a GI proprietary block cipher. The cipher key algorithm is not only secret (proprietary), but the key length is 64 bits compared to 56 bits in the data encryption standard (DES). A unique key is used to encrypt transmission to each remote ACD. In the very unlikely event that a key is broken, total system security can be quickly restored by deleting that key.

The pirate is faced with the formidable task of first breaking the control data encryption process to obtain the audio key, then using this key to break the audio encryption process. To make his task more difficult, keys can be changed frequently and may at any time be deleted.

As far as inter-system security is concerned, each Star-Lok system is provided at the time of manufacture with a system ID. The system ID is used in the encryption/decryption process, so that otherwise identical Star-Lok systems operating within the same footprint are unable to decrypt each other's transmissions. A total of 256 system IDs are accommodated within the Star-Lok architecture; each ID supports up to 16 million individual ACDs. A configuration in which several Star-Lok system operators elect to overlap their services in order to share a common subscriber ACD is also available.

Authorization Levels

Star-Lok provides 32 program authorization levels (tiers). The system operator is free to assign these tiers in any manner he chooses. Some will undoubtedly be assigned to regular channels a subscriber pays a flat monthly rate for. A subscriber's ACD is authorized via the control channel to descramble only those tiers to which he has subscribed. Programs assigned to other tiers are blocked in the ACD and not descrambled.

Other tiers may be assigned to special events programming. In this case, a subscriber may elect to view an event by contacting the business office in advance and agreeing to pay a surcharge for a particular program. The subscriber's ACD is temporarily authorized for the duration of the program and de-authorized at its conclusion.

A black-out scenario is the reverse of the above. ACDs in a particular geographic area are temporarily de-authorized during the event, then re-authorized at its conclusion.

Still other tiers may be assigned to impulse pay-per-view. In this case, ACDs of subscribers to the service are authorized for the IPPV tiers, however, descrambling does not take place until the subscriber has made the decision to purchase a particular program. A variable length descrambled preview time is provided to allow a subscriber time to decide whether or not to select a particular IPPV program. Several optional IPPV modes of operation are offered. These are discussed in the next section along with auxiliary data services and downloading of on-screen text.

Optional enhancements

IPPV is offered as an option in the Star-Lok system, and can be provided in either a pre- or post-pay configuration with or without audit trail.

No audit trail—credit draw down (pre-pay): In this mode, a message is sent to the ACD to establish an initial pre-paid credit balance. When an IPPV program is selected, the ACD decrements the balance by an amount specified in the program header, and the subscriber is permitted to view the program. Both program cost and credit balance are displayed on the screen of the subscriber's television set. When the credit balance is insufficient, further program viewing is not permitted.

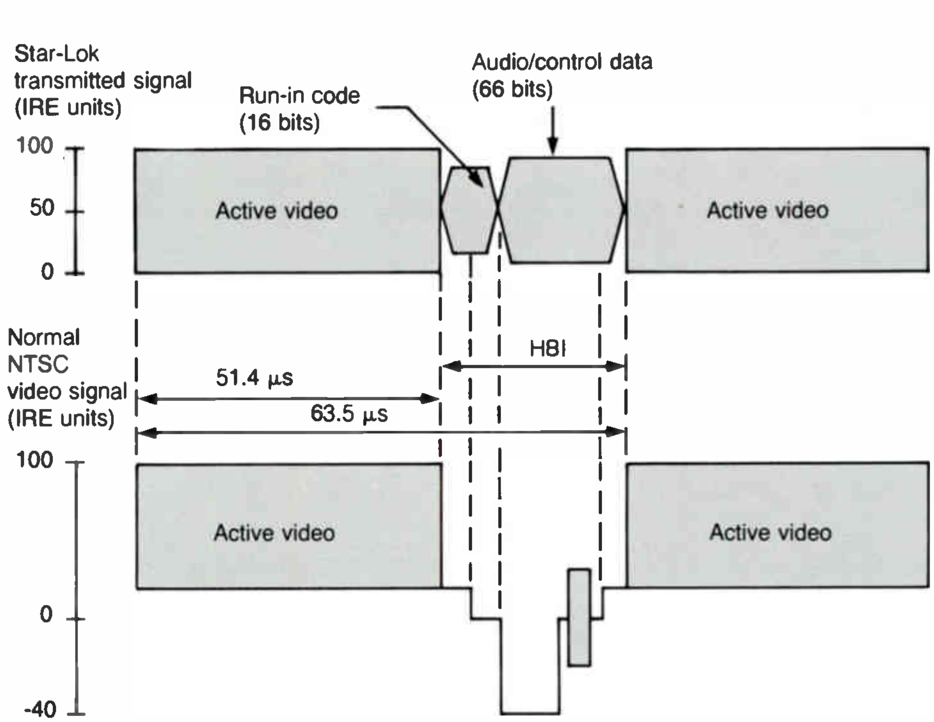
Audit trail—credit drawn down (pre-pay): This mode provides a transaction log (buffer) in the ACD, to store information on IPPV programs selected. This information is downloaded monthly to the business center by either a mailed credit card, or optionally, a self-contained telephone auto dial modem, which is used to produce an itemized record.

The post-pay scenario is similar to the above. Each subscriber is provided in advance with a credit balance and billed monthly for programs viewed.

Auxiliary data service: An auxiliary data channel may be optionally provided by making use of extra bits available in the HBI data stream. Auxiliary data and video-audio channels are separately addressable. The data channel may be optionally configured to provide rates from 9.6 KBPS to 56 KBPS. In systems requiring higher data rates, one of the audio channels may be used to obtain an additional 204 KBPS of data.

Downloading of on-screen text: The system may be optionally equipped to provide on-screen text for applications such as program guides, teletext or personal messages to individual subscribers. The HBI data channel is once again the transmission medium.

Figure 2: Scrambled transmission format vs. standard NTSC video



Satellite television scrambling with VideoCipher

Since 1982, M/A-COM has been involved in the development and production, of scrambling systems for the secure satellite distribution of video and audio. This line of scrambling systems is called VideoCipher.

By Mark F. Medress
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VideoCipher systems use the data encryption standard (DES) algorithm of the National Bureau of Standards for security protection. The systems produce a better descrambled signal than can be obtained with clear transmission, even at low carrier-to-noise ratios. Stereo digital audio, as well as flexible addressing and control of large numbers of descramblers in seconds, are key features. Since the audio information and control is transmitted during the horizontal sync interval, the need for audio subcarriers with their accompanying degradation is eliminated.

VideoCipher I descramblers are designed with discrete components for use in commercial applications. VideoCipher II descramblers are designed with custom VLSI circuit components for high-volume, low-cost consumer applications with direct broadcast satellite (DBS) systems, as well as for the broadcast, CATV and SMATV applications. The VideoCipher II system, because of its connection with CATV (the equipment has been selected by both Home Box Office and Showtime/The Movie Channel to scramble their satellite-distributed programming) will be the focus for the remainder of this article.

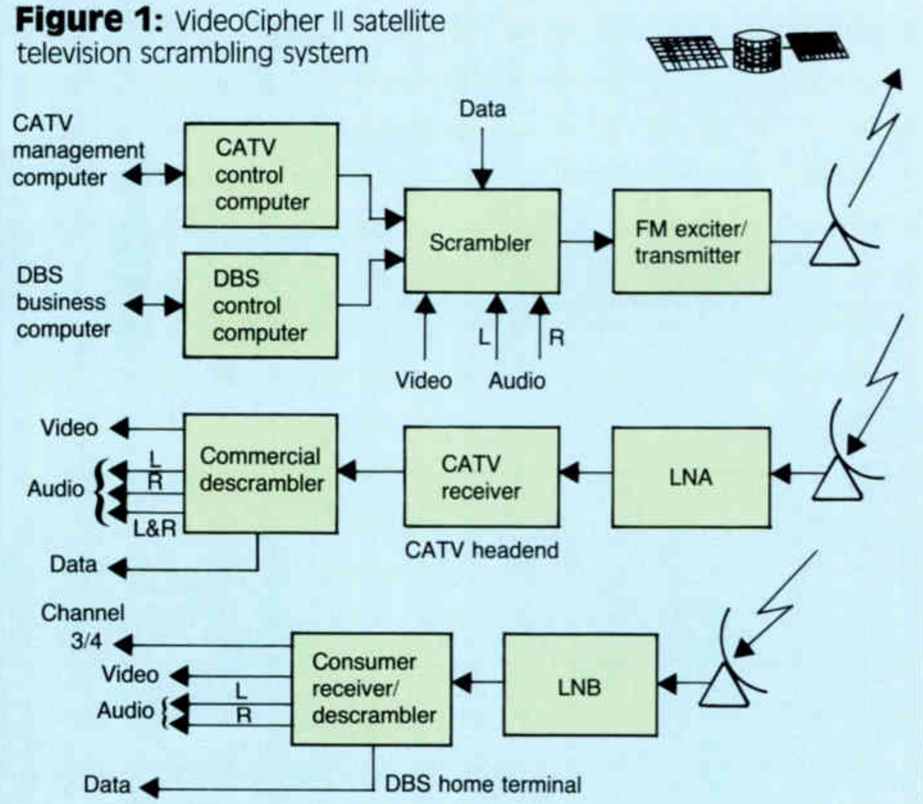
System overview

The basic elements of the VideoCipher II system are shown in Figure 1. The scrambler at each uplink accepts a standard NTSC video input, two audio inputs and an auxiliary data signal. CATV and DBS control computers transform authorization information into addressing and control data, which also is supplied to the scrambler. The scrambler processes all this information to produce a video output signal that has all its spectral energy contained within a 4.2 MHz bandwidth. The scrambled signal is then transmitted over a C- or Ku-band satellite to cable TV receiving locations, consumer TVROs or a combination of both.

At a cable headend, a commercial version of the descrambler processes the unclamped composite output of a standard FM receiver. If the descrambler is specifically authorized for a given program transmission, it reverses the steps performed at the scrambler to produce video, three audio outputs (left, right and mono), and the auxiliary data signal.

At a TVRO subscriber's home, a consumer satellite receiver contains a descrambler circuit card or is connected to a separate stand-alone descrambler. As in the CATV headend case, if the descrambler is authorized for a given program transmission, it produces baseband video for a monitor, two audio outputs or a stereo system, and a channel 3 or 4 remodulated video and mono audio output for a TV receiver. An auxiliary data output also is provided for downloading software, controlling various devices and similar applications at data rates up to 88 kilobits per second (KBPS).

Figure 1: VideoCipher II satellite television scrambling system



The scrambling process

The scrambler filters and digitizes the two audio channels at the same rate used in consumer digital audio discs. Each digital sample is then added to a random binary sequence generated by the DES algorithm, combined with error coding bits, and interleaved for transmission over the satellite channel. This processing provides bit-by-bit DES encryption. The encrypted audio bits appear to be completely random and can only be decrypted by a descrambler having the appropriate DES key. The processing also ensures that any burst errors appear as random independent errors after de-interleaving at the descrambler. In addition, the error coding scheme enables the descrambler to detect and correct all single bit errors, and detect and conceal (by interpolation) all double bit errors. The net effect is noise-free audio, even at low carrier-to-noise ratios.

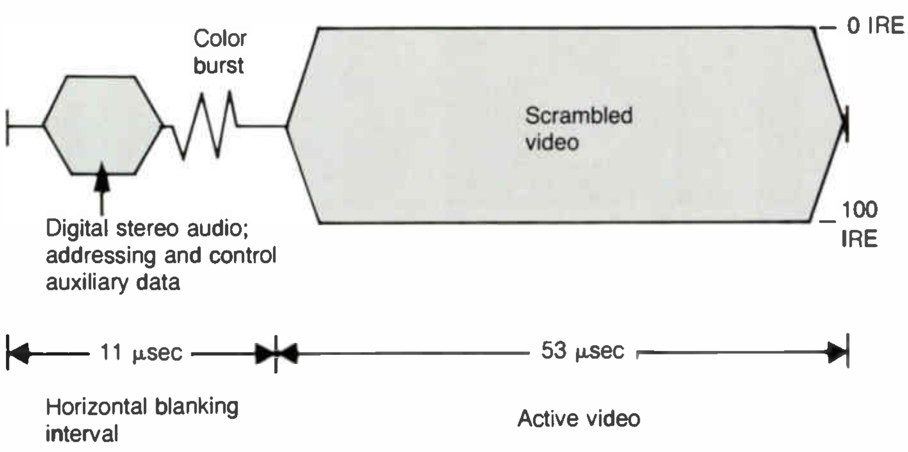
The two audio channels, along with the addressing and control information and the auxiliary data channel, are digitally transmitted in place of the horizontal sync pulse in each video line, as illustrated in Figure 2. Video security is provided by the absence of all normal sync information (both vertical and horizontal), by inverting the video waveform and by centering the color burst at a non-standard level. (A color burst at this level is unlikely to trigger the horizontal sync circuits of television receivers, including the new digital units.) The resulting picture is unintelligible. These descramblers use custom LSI chips to detect a digital sync pattern in each video frame and regenerate normal sync, thus making the video security difficult to defeat.

Since the audio, data and control information are all part of the 4.2 MHz video signal, no audio subcarriers or additional signal band-





Figure 2: VideoCipher II horizontal line format



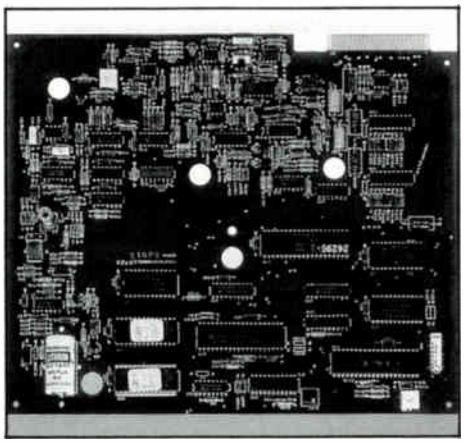
width are required. As a result, a signal scrambled with VideoCipher II shows up to a 2 dB advantage in video signal-to-noise ratio (for a given carrier-to-noise ratio) relative to an unscrambled signal.

Security and control

The DES algorithm provides the security in the VideoCipher II system. The security of DES is based on a 56 bit "key," which is analogous to a password. Without knowing the key, a DES encrypted message cannot be decrypted unless all 72,057,590,000,000,000 possible keys are tested by trial and error. All aspects of system control and usage authorization fall under the cloak of the cryptographic system. Even though a pirate may possess an authentic descrambler unit and a complete set of drawings, he would not be able to gain access to the system without a valid key being present in his unit.

Each descrambler has a unique address and a unique DES key contained in a microprocessor. (Actually, each descrambler has a number of unique DES keys for greater security protection.) To descramble a particular transmission, the descrambler must have the DES key used to scramble that program at the uplink. The program key is transmitted over the control channel to each authorized descrambler, after first DES encrypting it in that descrambler's unique key. Only the intended descrambler, therefore, will be able to decrypt the program key and obtain the program. By changing program keys at program boundaries and by distributing program keys appropriately, VideoCipher automatically authorizes and deauthorizes descramblers according to the schedule determined by the program provider.

For efficiency in the distribution of program keys, an intermediate key called the monthly key is used. For each billing period (a month for example), a monthly key and class of service (tiering) information are separately transmitted to each descrambler, encrypted in that descrambler's unit key. The program key (which changed every half-hour or so) is then encrypted in the monthly key before transmission. The net result is that all appropriate descramblers can be authorized for each program with a single transmission of the encrypted program key.



VideoCipher II consumer descrambler circuit card.

In addition to the regular transmission of monthly messages to active descramblers, new subscribers can be authorized; delinquent or terminating subscribers can be deauthorized, or those requesting a tier change can be accommodated using addressed messages that are transmitted immediately. With an addressing rate of up to 800,000 descramblers per hour, the VideoCipher II system can re-tier a large population of subscribers quickly.

As with the digital audio data, the control messages are error coded so they will be received correctly, even if bit errors occur during the transmission process. Monthly keys and other critical information are stored securely in the descrambler's non-volatile memory so they will not be lost during a power outage. This enables the descrambler to resume service almost instantly after power is resumed.

Protection against security compromise

The system has been designed so that the secret keys in each descrambler cannot be discovered even by opening the descrambler and probing its circuit components. If a descrambler is stolen, it can be terminated from the uplink. The stolen unit is then useless, since it cannot operate unless it receives proper authorization over the satellite channel.

At the uplink, the file of descrambler addresses and unit keys is itself DES encrypted, so that theft of the file must be followed by successful DES decryption for the file to be useful. Even if that were accomplished, a new file could be made with a different set of descrambler keys for the program provider to use from then on. Since each descrambler has many unique keys stored in it, no modification of deployed descramblers is required, and security is easily restored.

Tiered program service

Flexible control is provided for up to 56 independent tiers of programming that may be offered in any desired combinations. A tier can be general enough to include all programs on one or more channels, or specific enough to select one particular program on a specific channel (prepaid pay-per-view).

The tiering information is delivered to each descrambler in the secure, unit-addressed message that also contains the monthly key. The security system ensures that a descrambler only can receive programming in tiers for which it has been authorized. The control channel cannot be interrupted or modified to allow reception of unauthorized programming.

By providing separate tiering information for CATV and DBS descramblers, each programmer has independent control of his channel's cable and SMATV affiliates. Consumer tiering can be common across all channels for a DBS service. Although subscriber tier changes nominally would be made at monthly (or other billing cycle) boundaries, changes can be made at any time. This feature is useful for the addition and deletion of subscribers.

Multichannel operation

The VideoCipher II system is designed for flexible operation in a multichannel environment, as illustrated in Figure 3. A CATV control computer for each channel generates the authorization information for that channel's dedicated CATV and SMATV descramblers. A central DBS control computer, which can be driven by a number of independent business computers, creates authorization messages for all DBS customers. These messages are distributed to all channels and combined with the channel-specific authorization. With this architecture, a consumer descrambler is exposed to its authorization data, no matter which scrambled channel it is tuned to.

A common DBS monthly key is used to encrypt each DBS program key on every channel. The tiering structure is used both across and within channels to differentiate service to each DBS subscriber. When a subscriber switches from one scrambled channel to another, he would already have the monthly key needed to decrypt the new channel's program key (which is transmitted many times a second). He therefore would begin viewing the new program almost instantaneously, if this program was within his service tier.

Program blackouts

Some programs (such as sporting events) may have to be blacked out to both CATV and DBS descramblers in certain regions of the country. CATV and SMATV descramblers are automatically blacked out by placing them in tiers not authorized for the program in question. Due to their much larger numbers, DBS descramblers are blacked out with a different mechanism.

When a DBS subscriber requests service, his descrambler is assigned an x-y coordinate location based on his ZIP code. In initially authorizing each descrambler, the VideoCipher II system transmits that descrambler's coordinate location over the satellite channel for future use. If a particular program is to be blacked out, the program supplier would be able to define up to 32 independent blackout regions by specifying the center and radius of a circle for each region. Each descrambler, after receiving the blackout region information, would compute whether it was outside of all blackout regions, and if so, would allow viewing of the program. The program supplier also can specify an alternate channel that the receiver/descrambler would automatically retune to if it were in a blackout region.

Consumer features

The VideoCipher II system has a number of consumer features that enhance the value of a DBS customer's scrambled service.

On-screen display: Many of the subscriber-related system features depend on the descrambler's ability to generate an alphanumeric text display on his TV screen. The display format, nine lines of 20 characters each, is superimposed over the video picture and uses large, easy-to-read characters. The display text can be generated by:

- Messages stored in read-only memory, such as: "Sorry, but you are not authorized to receive this program."
- Messages transmitted over the satellite channel, such as the name of the current program.
- Numbers entered by the subscriber using his infrared remote control, such as a password.

The on-screen display provides feedback and information to the subscriber. It prompts him in making selections, provides help when he is unsure of how to use a particular system feature, and allows him to access text data bases and other information transmitted by the VideoCipher II.

Impulse pay-per-view: In addition to providing a prepaid pay-per-view capability through the tiering structure, VideoCipher II also implements an impulse pay-per-view (IPPV) feature that does not require a telephone call or pre-subscription on the part of the subscriber. The IPPV capability is built around a secure and tamper-proof credit register contained within each descrambler. Access to IPPV features can be controlled by the subscriber through a user-defined password.

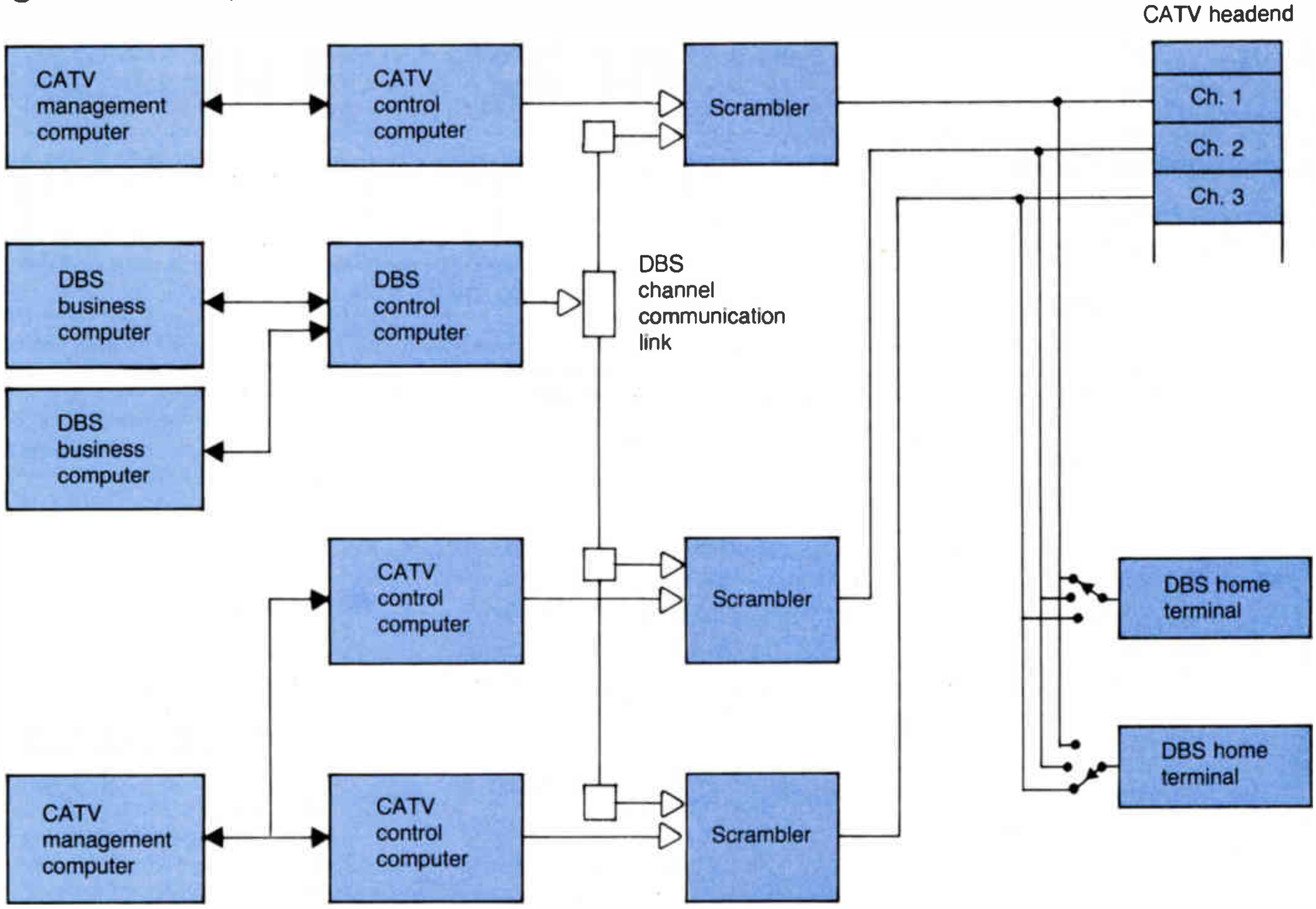
When advance IPPV payments are made by the subscriber, a secure message is sent to the subscriber's descrambler, which increments the credit register by the amount of the payment. After an IPPV selection is made, the credit register is decremented by the cost of the program. The on-screen display shows the IPPV program name, rating, cost, credit available to the subscriber and time remaining in the program. The subscriber is prompted to aid him in entering the information necessary to buy an IPPV program. The descrambler will, of course, not allow purchase of an IPPV program if sufficient credit is not available.

The descrambler keeps track of the IPPV programs purchased by the subscriber. This information can be displayed to the subscriber as a list of titles for his own review, or as a set of coded numbers that can be sent to the program supplier for allocating IPPV revenues. The credit register itself is contained in secure non-volatile storage, so it is protected against both tampering and power outages.

Program rating lock out: Using the keypad and on-screen prompts, the subscriber can set a rating lock-out level and prevent the reception of programs with a higher rating. The seven possible rating levels can be displayed by the descrambler as numerics or as movie industry ratings.

Access to the lock-out level change feature is made by means of a subscriber password.

Figure 3: VideoCipher II multichannel CATV and DBS operation



Correctly entering the password when prompted allows the subscriber to change the lock-out level. The subscriber can change passwords (rating lock-out and IPPV) by using the keypad and prompts from the on-screen display. In creating a new password, the subscriber must first correctly enter the old one.

Message and text services: The DBS operator can send electronic text messages to individual subscribers or to tiers. Individual messages are displayed under subscriber control on his TV set. These allow the operator to inform him of a change in status ("You were sent more IPPV credit on 9/18/85"), to send material requested by the subscriber (closing quotes on a personal stock list), and to transmit other subscriber specific information. Messages also can be sent to all subscribers of a particular tier for immediate display, such as a reminder of a special upcoming program.

In addition to the message service, the VideoCipher II system also supports an information service capability. This service allows DBS subscribers to access text data bases broadcast by the programmers, such as a program guide and news services. Up to 256 different pages can be transmitted on each channel, organized into any number of scrolls with whatever levels of hierarchy the programmer desires.

Other on-screen displays: When a DBS subscriber changes channels or a new program begins, the descrambler automatically displays the name and time remaining in the current program. The "program name" can be any text message up to two lines in length.

The consumer descrambler version also can generate a diagnostic display that contains information to verify correct operation of the subscriber home terminal or to indicate and help isolate failures. The display shows the descramblers address, the received signal quality and the descrambler authorization status. The diagnostic screen can be an aid to the service technician. The subscriber also can give diagnostic information over the phone to a service technician, which may indicate a remedy to his problem without a service call.

Dual language capability: The two digital audio channels can be either a stereo pair, or two independent audio signals for supporting a dual language capability. In the latter case, a control channel message instructs the receiver/descrambler to switch to a mono mode and route one audio channel to all audio outputs. The switching is performed on the digital audio data, thus providing channel separation of at least 75 dB. The subscriber can use his keypad to determine which audio channel, and therefore which language, is routed to his audio outputs for listening.

Summary

The VideoCipher II system represents a state-of-the-art design in secure satellite video distribution to cable and DBS descramblers. A spare VideoCipher II cable descrambler can support multiple services, with each program provider having independent and secure access to the descrambler. A single DBS consumer descrambler can be authorized to receive all VideoCipher II scrambled channels. Consumer descramblers also include subscriber features for receiving text messages and data bases, for impulse purchases of pay-per-view programs, and for viewing control by program rating.

Mark Medress joined M/A-COM Linkabit in August 1982. His major focus has been on the technical development and marketing of the VideoCipher product line, which includes systems for encrypting satellite television signals. From 1979 to 1982, Medress was manager of Speech Processing Research at ITT's Defense Communications Division in San Diego. From 1969 to 1979, he was with Sperry Univac's Defense Communications Division in St. Paul, Minn. Medress has authored or co-authored over 30 technical papers. He has also made numerous presentations at technical meetings and conferences both in the United States and internationally.

Individual converters can now be specifically identified and addressed from the cable operator's office, making the converter totally useless outside that specific system.

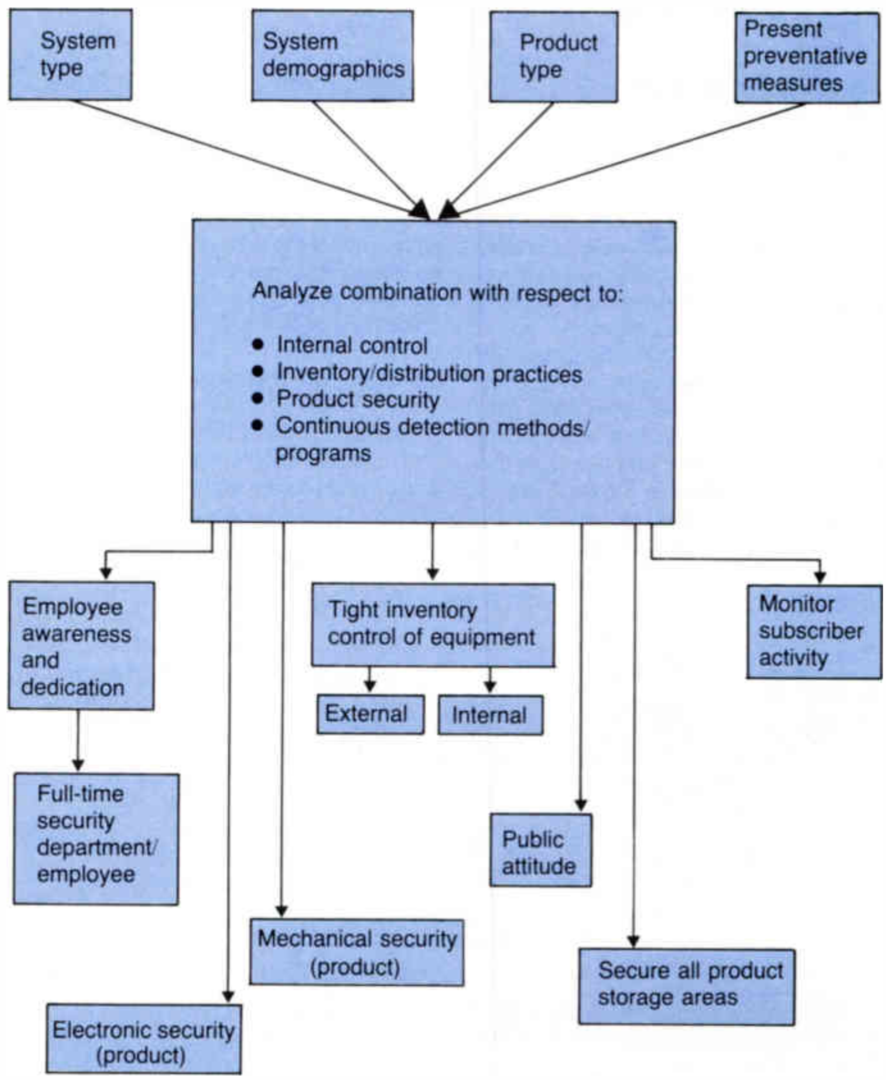
Additionally, there are digital addressable converters available that offer dynamic RF sync suppression scrambling, which also eliminates the concern over existing pirate boxes in the field, since these boxes cannot descramble the signal. And from a cost/security standpoint, the dynamic RF scrambling method is thought by many to suit their needs better than baseband scrambling (one reason contributing to the continued dominance of RF scrambling systems in the addressable marketplace).

More than hardware solutions

Turning to a quite different approach to controlling theft of service, Jerrold offers cable operators something called the EPIC program. EPIC, which stands for electronic program intrusion control, is a proprietary system design that can be used by operators who suspect signal theft is taking place in their systems. The program identifies signal pirates and quantifies the signal theft problem. EPIC produces interference with the picture reception in a signal thief's converter. However, it will not affect a legal subscriber's reception.

The core of EPIC centers around a specially designed scrambler plus a modulator and demodulator, all completely contained in a cabinet. Used in both pay and addressable systems, EPIC can be installed in conjunction with an existing clear channel processor or modulator/demodulator sets. The system's actual method of operation cannot be revealed. It is also important that knowledge of the presence and planned use of EPIC within a cable operation be kept to a minimum of key personnel. Field experience has shown that use of EPIC in a system beyond a 30-day period negatively impacts its effectiveness as a piracy detection system. EPIC is available to cable operators at no charge for a limited period of time on a request basis.

Figure 2: Maintaining a security system program



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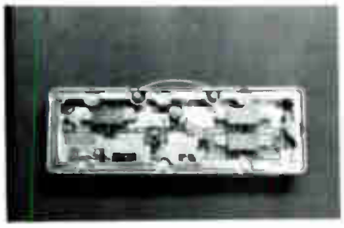
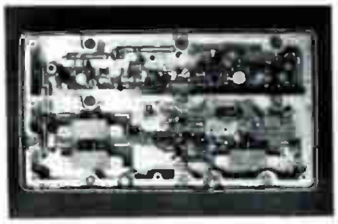
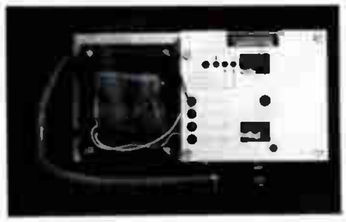
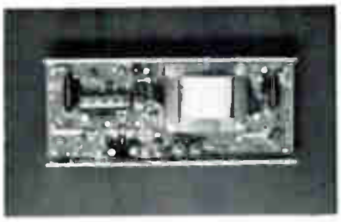
QUALITY RF SERVICES proudly presents "P²" (power/doubling/paralleling). The term "P²" refers to two hybrids operating in parallel to reduce each individual hybrid's output levels by 3dB (half power), then combining the two hybrids levels for twice the normal output power, (3dB higher output levels) without increasing distortions. Latest generation hybrids also improve our "P²" specifications above any conventional amplifier available on the market today. This means a system can be upgraded for more channels without sacrificing engineering specifications.

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SPECIFICATIONS

STATION FUNCTION	TR. AMP W/ASC BR. AMP.	TR. AMP — BR. AMP.	TR. AMP W/ASC —	TR. AMP — —	TERM./INT. TR. BR. AMP.	LINE EXTENDER
STATION MODEL NUMBER AVAILABLE in P² OR PUSH PULL ONLY						
PASSBAND	50 to 330 MHz			50 to 400 MHz		
RESPONSE FLATNESS (See Note 1) Trunk Amplifier	±.2dB	±.2dB	±.2dB	±.2dB		
Bridger or Distribution Amplifier	±.5dB	±.5dB			±.5dB	±.5dB
MINIMUM FULL GAIN (See Note 2) Trunk Amplifier	29 or 31dB	30 or 32dB	29 or 31dB	30 or 32dB		
Bridger or Distribution Amplifier	30dB	30dB			44[illegible]	28dB
RECOMMENDED OPERATING GAIN at 330 MHz, without equalizer Trunk IN to Trunk Out	26/22dB	26/22dB	26/22dB	26[illegible]B		
Trunk IN to Bridger (Distribution) OUT	40/34dB	40/34dB			38/32dB	26dB
TYPICAL OPERATING LEVELS for 40 channels, with equalizers IN	9dBmV	9dBmV	9dBmV	9d[illegible]	10dBmV	
Trunk OUT 330 MHz Linear TILT	34/30dBmV	34/30dBmV	34/[illegible]dBmV	[illegible]/30dBmV		
Trunk OUT 400 MHz Linear TILT	34/29dBmV	34/29dBmV	3[illegible]29[illegible]mV	34/29dBmV		
Bridger (Distribution) OUT	49/42dBmV	49/42dB[illegible]			49/42dBmV	48/42dBmV
DISTORTION CHARACTERISTICS (typical for op. levels)						
2nd Order Beats, Chs. 2, 20(g), 13 Trunk Amplifiers	-84dB	-85dB	-84dB	-85dB		
Bridger or Distribution Amplifier	-72[illegible]	[illegible]2dB			-70dB	-71dB
Composite Triple Beat — Trunk 330 MHz	-90[illegible]	-91dB	-90dB	-91dB		
Trunk Amplifier — Trunk 400 MHz	[illegible]87d[illegible]	-88dB	-87dB	-88dB		
Bridger or Distribution Amplifier — 330 M[illegible]	-69dB	-69dB			-67dB	-69dB
Cross Modulation — [illegible]0 M[illegible]	-64dB	-64dB			-62dB	-65dB
HUM MODULATION (by 60 Hz line)	70dB ALL STATIONS					
MAXIMUM NOISE FIGURE, without equalizers — [illegible] MHz	7.0dB	7.0dB	7.0dB	7.0dB	8.0dB	9.0dB
400 MHz	7.5dB	7.5dB	7.5dB	7.5dB	9.0dB	9.5dB
MANUAL GAIN CONTROL RANGE, mimimu[illegible] Trunk Amplifier	8dB	9dB	8dB	9dB		
Bridger or Distribution Ampli[illegible]r	9dB	9dB			9dB	9dB
OPTIONAL INPUT LEV[illegible]ADDING	AVAILABLE PLUG IN PADS S X P'S					
MANUAL SLO[illegible] CONT[illegible]E, minimum [illegible] Brid[illegible]r D[illegible]stribution Amplifier (Ch. 2/36)	8dB	8dB			9dB	7dB
AUTOMATIC S[illegible]ND GAIN CONTROL For changes in cable (ref. to 330 MHz)	+3/-3dB		+3/-3dB			
Amplifier output at pilot frequency holds at	±.5dB		±.5dB			
CONTROL CARRIERS AGC factory tuned to Ch. AS REQUESTED	AS REQUESTED					
Operating Level, minimum/maximum dBmV	SELECTABLE PLUG IN PAD S X P's					
THERMAL COMPENSATION for ambient changes in amplifier over °F.	AVAILABLE AS OPTION					
THERMAL MATCH at 75 ohm Impedance	16dB MINIMUM ALL PORTS					
POWER REQUIREMENT (In Station Housing) Using QRF-JPP2 — 60 V System Watts Amps	1.07A	1.02A	.650A	.590A	.590A	.505A
30 V System Watts Amps						
DC OPERATING VOLTAGE (AVAILABLE IN -27V, ALSO)	-23Vdc	-23Vdc	-23Vdc	-23Vdc	-23Vdc	-23Vdc

(Quality RF Services is not a sales agent for Jerrold Electronics)

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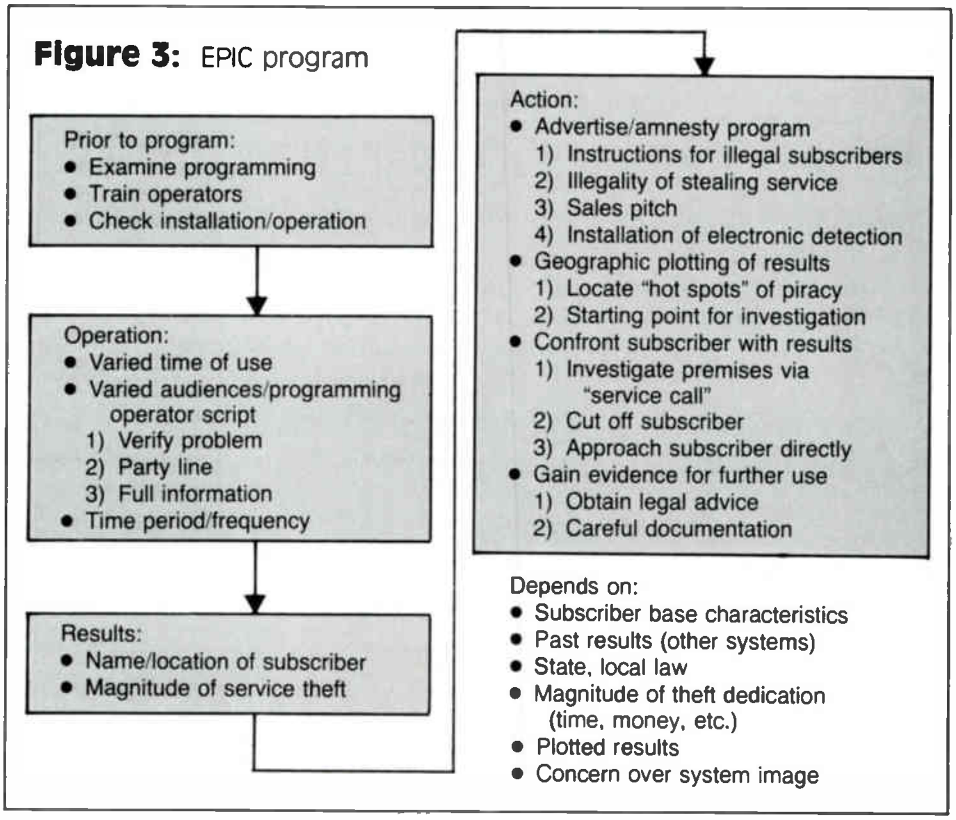
Figure 3 outlines the steps necessary for cable operators when implementing the EPIC program. It can be used to kick off a larger system security program or activated somewhere in the middle of a security campaign. EPIC is only one possible measure in the establishment of a total signal security program that should also include: tap audits; analysis of local service churn; educational/promotional programs for employees, subscribers and local authorities; amnesty programs; legal prosecution of pirates; establishing effective internal control over inventory and service cancellations; setting up enhanced security measures for equipment—warning labels, riveting doors and covers; and appointment of a signal security manager.

Figure 3: EPIC program



The EPIC detection system, while no panacea, will be most effective when combined with the aforementioned elements to make a complete theft-of-service program. And it cannot be stressed enough that cable system operators need to plan well, execute precisely, and follow up diligently with such programs.

The Jerrold Division, in joint cooperation with parent company General Instrument (GI), provides other support services to the cable industry on theft-of-service problems. One area is aiding cable operators in the break-up of illegal distribution rings of pirate boxes (modified converters). Electronics distributors and similar enterprises view the cable industry as a ripe market for retail activity. Through aggressive tracking and cooperation with cable operators, as well as statutory laws supporting theft of service as a crime, illegal distributors are finally being prosecuted successfully. Sting-type operations are proving to be effective means of gathering and documenting evidence used as leverage in eventual legal prosecutions.

When a cable operator does bring a distributor or an individual subscriber to trial, Jerrold will support the case with an engineer who testifies as an expert witness. Under oath, the technical expert verifies that a converter/

descrambler or descrambler has been tampered with, either mechanically or electronically, for the purpose of authorizing all premium services.

Screening programs are another way equipment manufacturers are taking aggressive steps to ensure that descrambling product does not fall into the "wrong" hands. All descrambling-type converters or parts are screened before an order is accepted and shipped. All shipments made are to legally franchised cable operators only. Additionally, accurate records are maintained as to how many converters are produced in the factories, when they enter and leave customs, and the number of converters shipped and received by customers. This is accomplished through individual converter serial number data, logged for all subscriber terminals shipped.

In large measure, due to the diligent efforts of Ron Putnam, GI's corporate director of security, much of the leakage of Jerrold converters to illegal distributors has been eliminated. However, one of the problems Jerrold has faced in dealing with piracy is that most of the illegal converters in the market bear Jerrold's brand name, due primarily to the company's large installed base of converters. The majority of this equipment is not new and is not acquired directly by illegal distributors from Jerrold, but is used inventory from cable operations. It is, therefore, important for cable operators to be aware who they sell their used converters to as this is a major source of pirate converters for illegal distributors.

These procedures, policies and services as related to security and theft of service have gone a long way toward helping cable operators get a firmer grip on the theft-of-service problem. One place where there's been much progress is the area of legislation. All states now have a set of laws on the books governing theft of cable service. Because each one has a different law, the National Cable Television Association (NCTA) has compiled a sketch of these laws in "An Overview of State Theft of Service Laws." (Copies of this summary may be obtained from NCTA's State Government Relations Division.)

Under the heading, "Key Elements of Theft-of-Service Laws," the NCTA delineated four key areas considered crucial in establishing state cable theft-of-service laws. That section is reprinted here.

1) *Type of law:* The law should specifically state that it applies to theft of cable television services. Broadly worded telephone and utility theft laws generally in effect in most states may be available for prosecution of cable thieves. Nevertheless, a cable-specific law eliminates any doubt as to its applicability and, furthermore, reinforces the concept that cable is separate from telephone and other utility services.

2) *Prohibited activities:* The most basic offense that is included in nearly every state theft law is unauthorized reception of the cable service. Unauthorized connections are also commonly included as they evidence the illegal reception and are easier to prove. Also recognized is the need to cut off the supply of devices used for illegal hook-ups and the prohibition of the manufacture and/or sale of these devices. Unauthorized possession of devices is also sometimes illegal.

3) *Presumptions:* A number of state statutes provide that presumption of intent exists when certain facts such as the presence of unauthorized or altered devices is established. Similarly, a presumption of intent to sell illegal devices is provided when a person has an unusually large supply of them in his possession.

4) *Penalties:* All the states provide criminal penalties for theft of service. There are two schools of thought as to how harsh these penalties ought to be. The first says that severe penalties will deter future offenders. Thus, a number of states make theft of service a felony carrying prison terms and fines up to $5,000. Others suggest, however, that if penalties are too severe, prosecutors and judges will be hesitant to have defendants convicted. Many states, therefore, make cable theft a misdemeanor. The more effective approach depends on the attitudes prevailing in the state.

A combined effort

There are, indeed, many ways to fight theft of service and prevent equipment tampering. It is important to realize that responsibility for awareness and prevention of this problem doesn't fall onto the shoulders of any one organization (cable operator, equipment manufacturer or programmer). Instead, it should be an effort among all organizations involved in the industry.

Illegal use of basic, tiered and pay services

This article will be a general overview, addressing many areas that have the potential of creating illegal use of system operated cable services.

By Austin Coryell
Director of Engineering
American Television and Communications

The ultimate goal of every system operator should be to try to increase his system's penetration of services to its maximum. To accomplish this, every employee must be dedicated to providing the best product with good service to their subscribers; and have a dedicated program with well-planned procedures to circumvent both subscriber and non-subscriber from using services illegally.

The majority of systems have been growing over the past few years by building new plant, rebuilding or upgrading old plant, and adding additional services. This has kept everyone exceedingly busy. As systems wind down on these major projects, it will be necessary to re-evaluate their growth potential. In many instances, systems will find there are very few major new areas to build to increase potential revenues. It will become necessary for everyone to become more professional in providing better service, product and operating a business if they are to succeed in making substantial increases in system penetration to improve each system's overall financial posture.

Illegal use of services is becoming a great concern; especially since several levels of pay are being implemented in most systems. If each system could increase its overall penetration by just 1 percent, overall gross annual revenue would be increased as well. At ATC we are positive every system can exceed a 1 percent increase in penetration by just concentrating on the illegal use problem.

Before going further, the major difference between theft of service and illegal use of service needs some explanation:

- *Theft of service*—This is where a non-subscriber or subscriber is intentionally defrauding the company by personally tampering (or having someone else tamper) with the cable, terminal and/or equipment on their premises or purchasing equipment intending to obtain services of which they are not entitled.
- *Illegal use of service*—This is where subscribers and non-subscribers are using cable services to which they are not entitled. These individuals have access to these services because of a system's neglect to incorporate and practice good operating procedures to discourage illegal use of services.

From experience, the majority of losses in revenue are caused by illegal use of service. This is a problem that can be overcome by every management and supervisory person making all employees aware of its seriousness, establishing and following through with good operating procedures, and encouraging the initiative and creativity of the individual employees to help resolve this significant loss of revenue. The individuals working in the office and in the field are well aware of the methods and areas where illegals are prevalent. Use this information and these individuals' talents to improve upon this major problem.

'Because of a system's neglect to incorporate and practice good operating procedures... the majority of losses in revenue are caused by illegal use of service'

Reducing theft and illegal use

Areas where improvement can be made to reduce theft and illegal use of services are:

1) All service and installation work orders going to the field should show all the services each subscriber is entitled to. When the installers or service technicians are on the premises, they can verify these services. Should there be a discrepancy, it can be taken care of per established system procedures. All work orders returning from the field should designate the status of service; and someone should review these work orders to retrieve data and follow through.

2) All installation work orders should be accounted for. Without proper procedures, it could be possible for someone to makeup a work order for increased services; then when the work is completed, the same individual either voids the work order or throws it away, thus giving someone free service.

3) Tight control should be maintained on all courtesy accounts. A work order should be issued before any free installations are made in the field. When an employee terminates, one of the items on the employee check off sheet should indicate whether a drop has been disconnected and the terminal retrieved, or if the employee has been converted to an active subscriber. A large system with a high employee churn could generate a high illegal rate over a period of time.

4) All contractors have access to installation materials, especially contract installers. The system should require all contractors to provide, and keep up-to-date, the addresses of all their employees that reside in the cable areas. As each contractor employee leaves the area or moves, someone should check the residence to ensure the drop is disconnected.

5) All installation materials issued to contract installers, and our own installers, can be monitored to determine if more than average amounts of materials are being used for installations. This can identify persons doing illegal installations, selling installation materials and/ or wasting materials.

6) Procedures should be established for following through on disconnects by mistake. Many illegals are caused because the individual reconnecting a disconnect by mistake does not follow through to determine the correct party that should have been disconnected. This is very time consuming in many cases for various reasons. Some examples are: a) right address but wrong adjacent street because installer did not pay attention; b) right street and address but wrong community; c) right street name and address but did not observe whether it was a street, avenue, circle, drive, boulevard, etc.; and d) unidentified drops in pedestals, panels and clusters on poles making it difficult to determine correct drop.

7) Sample audit all contract installers and your own personnel (including sales) to ensure they are not giving away services directly or indirectly. Paperwork disconnects and additional outlets are a constant problem.

8) The system should have an aggressive program for retrieving converters and decoders. All tiered systems that have a high terminal loss will have a high percentage of tier and pay illegals.

9) All systems should have their local identification on their terminals. This way technicians and installers can identify illegal terminals.

10) All decoder boxes should have a non-removable stick-on seal put over a screw or cabinet to chassis joint. Tampering with these boxes can be detected if the seal is broken.

11) In non-scrambled tiered systems, which did not install band reject filters, all employees should be on a constant watch for cable-ready sets, VCRs and illegal converters. When these sets, VCRs and/or illegal converters have been identified, either sell the tier service or install band reject filters.

12) Systems that have an active RF leakage program: find a lot of illegal outlets and non-subscribers due to the tampering with the cable; find severe leaks in the cable caused by sheath cracks, loose connections, corrosion, loose lids on amplifiers, and defective passives in trapped systems enabling non-subscribers to receive pay services with a rooftop antenna and preamp; and find defective traps that are letting subscribers receive pay services illegally.

13) All drops in pedestals, apartment boxes and bundles on buildings or poles

should be identified for easy recognition. This will encourage all installers to connect and disconnect the right parties the first time. Most systems that do not identify their drops experience a high percentage of illegals in these areas.

14) Many systems tag their drop cables to designate the type of services the subscriber is entitled to as follows: a) disconnected drops are tagged with a piece of yellow phasing tape and tied back (when a connected drop is spotted, with the yellow phasing tape still on the drop, the drop is an illegal suspect); b) all drops feeding more than one subscriber are tagged with a piece of red phasing tape (this lets everyone know that all reconnect, disconnect, and trapping work must be made at the terminal on the building; and c) different levels of pay services are noted by installing colored tags on the drops.

15) Many systems use security devices to discourage persons from tampering with the cable, such as: a) locking terminators used to terminate unused ports of directional taps; b) security shields used on all F connectors to prevent persons from removing connectors; and c) security sleeves used to prevent persons from removing traps to receive pay services.

16) All pedestals should have some type of locking mechanism to prevent persons from getting into them. Also, cable passives should be mounted to the pedestal stake so that the pedestal cannot be removed.

17) All apartment boxes should have some type of locking mechanism to prevent persons from gaining access to drops and peripheral hardware. These boxes and panels should be designed so that hinges or locks cannot be easily broken, and made of materials that will not rust causing long-term rust marks and streaks on the buildings. All keys and special locking tools should be controlled by issuance. When employees and contractors terminate their services, these keys and tools should be returned.

18) Incoming new traps should be checked to determine if they are meeting their design specifications. All traps being returned from the field should be checked to determine if traps are defective or have changed parameters due to handling and aging. As well, traps should be handled properly and taken care of. In many systems, traps are thrown in the back of the truck, stepped on, materials thrown on top of them, and rained on. This is a very poor way to take care of these traps, especially when their primary function is to prevent subscribers from receiving pay and tiered services. Many systems use color-coded traps so a subscriber's service level can be easily identified.

19) Supervisory persons should constantly strive for excellence in their personnel with continual training and encouragement and follow through on their work.

20) In states where tampering with the cable system is illegal, an active program should be established to prosecute persons who actively and deliberately steal cable service.

21) All systems should do sample audits at least twice a year. Many larger systems have full-time audit personnel whose primary responsibilities are to seek out illegal subscribers and poor work practices of in-house and contract installers that create illegals. In the majority of systems, an active perpetual audit program is the best approach to reduce the illegal problems.

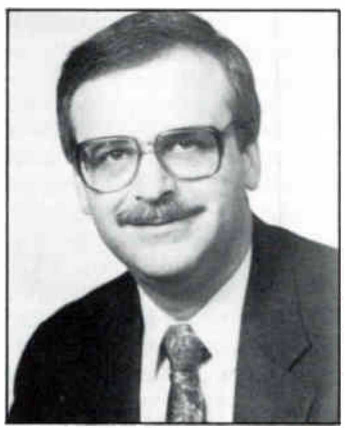
22) Many illegal converters and decoders get into the field in systems that have very poor control of these pieces of equipment. Proper control requires that they must all be: a) accounted for from the date they arrive in the warehouse until they are written off the books; b) secured under lock and key at all times (in the warehouse, converter repair, front office, cable stores and vehicles); c) issued to persons that have a signed authorization slip from predesignated supervisory company personnel; and d) reconciled periodically to ensure all converters are accounted for. If not, take corrective measures to solve loss problems.

23) In systems with addressability, it is very important that the technical personnel responsible for the set up and maintenance, have a thorough knowledge of the entire system. All equipment purchased should be quality checked at least on a sample basis and all converters returned from the field should be checked. Over time, due to aging of components, converters could be authorizing programming that the subscribers are not entitled to.

KEEPING TRACK

Richard Perry has been named president and chief executive officer at **C-COR Electronics Inc.** James Palmer, formerly president and chairman, will remain as chairman of C-COR and will devote full time in that position. Prior to joining C-COR, Perry was founding president and chief executive officer at FirsTel Information Systems Inc., a subsidiary of US West. Previously he was employed by Northwestern Bell Telephone Co. for 32 years. Contact: 60 Decibel Rd., State College, Pa. 16801, (814) 238-2461.

Thomas Lacey has been named vice president of operations for **Tribune-United Cable** of Montgomery County (Md.). Most recently, Lacey was vice president of operations for the Southern Division of Capital Cities Cable Inc./Cablecom-General. He was responsible for the general management of 23 cable television systems. He also has held positions with Borden Inc., General Electric Co. and Standard Oil in sales, market research and economic research. Contact: 1000 Wyckoff Ave., Mahwah, N.J. 07430, (201) 891-7988.



Blecker

Times Fiber Communications Inc. has announced the appointment of **Marvin Blecker** as vice president of engineering. Prior to joining TFC, he was director, systems engineering and development for COMSAT's Satellite Television Corp. Previously, he was with RCA Laboratories for 11 years. From 1978 to 1984 he was head of systems evaluation research. From 1976 to 1978, he was manager, management information systems; earlier, he was a member of the technical staff at RCA Laboratories and a systems engineer at the GE Space Division.

The Cable Products Division of Times Fiber also announced the appointment of **Tony Acri** as district sales manager for Southern New England. Acri previously worked for Times Fiber in the position of inside salesman for the company's Industrial Products Group. He left that position in 1978 to join International Microwave Corp., where he most recently was vice president, sales and marketing. Contact: 358 Hall Ave., Wallingford, Conn. 06492, (203) 265-8500.

Avant-Garde Computing Inc., a maker of communications network management products, announced two new senior executives.

John O'Connors has joined the firm as senior vice president of engineering, a new position. He formerly served as vice president of computer operations and data communications for Shearson/Lehman Brothers.

In a second change, **William Angus III** has joined Avant-Garde as senior vice president of finance. Angus has served as a director of Avant-Garde since 1980 and before that as a financial consultant to the company since its founding. Contact: 8000 Commerce Pkwy., Mount Laurel, N.J. 08054-2227, (609) 778-7000.

Dutton

John Dutton has been appointed senior vice president and elected to the board of directors of **Tamaqua Cable Products Corp**. As vice president of engineering since the company's inception, Dutton managed Tamaqua's engineering, cost accounting and quality control programs. Prior to joining Tamaqua, he was employed in the United Kingdom as an engineer at Greengate and Irwell Rubber Co. and Mersey Cable Works, and was production manager at Enfield Standard Power Cables and ESPC. Contact: P.O. Box 347, Schuylkill Haven, Pa. 17972, (717) 385-4381.

Brenner

Carroll

Eastman Kodak Co. announced its management team for Lamdek Fiber Optics. The new Kodak business unit will initially offer a high-precision, field-installable connector and related products for single-mode optical fiber.

Barry Brenner has been appointed vice president and general manager of the unit. Brenner joined Kodak in 1973 as a research physicist in the Kodak Research Labs. Since 1979, he has held a number of positions in marketing and business planning.

James Carroll has been named manager of engineering and manufacturing. Carroll joined Kodak in 1964 as a development engineer in research and engineering at the Kodak Apparatus Division (KAD). He has held a number of posts in research and engineering at KAD, serving most recently as a supervisor of optics new process development. Contact: Eastman Kodak Co., 343 State St., Rochester, N.Y. 14650, (716) 724-5802.

Zenith Electronics Corp. named **Robert Dilworth** president of **Zenith Data Systems Corp.** Since 1982, Dilworth has been president of Morrow Designs Inc., a privately held microcomputer company based in California. Previously, he was president of Ultra Magnetics and held senior marketing and financial positions with Varian Associates and Sperry Corp. Contact: 1000 Milwaukee Ave., Glenview, Ill., 60025, (312) 391-8181.

Anixter Bros. Inc. announced the elevation of several of the company's top executives and the addition of an outside director. **Alan Anixter**, president and CEO, becomes chairman and remains CEO.

Three vice chairmen were elected. They are: **William Anixter**, senior executive vice president; **James Anixter**, executive vice president and assistant to the president; and **Bruce Van Wagner**, president of Anixter Communications and executive vice president-international.

The company formed an executive committee composed of the chairman and three vice chairmen: **John Pigott**, executive vice president-administration, was elected president of Anixter Bros. Inc., the parent company. **John Egan**, formerly executive vice president-operations, is now president of Anixter Communications. **Robert Wilson**, previously vice president-sales, becomes president of Anixter Wire and Cable. The board of directors has been expanded with the election of **Scott Anixter**, an independent investor. Contact: 4711 Golf Rd., One Concourse Plaza, Skokie, Ill. 60076, (312) 677-2600.

Vito Brullo has been promoted to the position of manager-service and custom manufacturing at **Blonder-Tongue Laboratories Inc.** Brullo is now responsible for the general management and daily operations of the company's custom manufacturing and service departments. Brullo has been associated with Blonder-Tongue for over 20 years. Contact: 1 Jake Brown Rd., Old Bridge, N.J. 08857, (201) 679-4000.

Barton

Douglas Barton has accepted new job responsibilities at **Mycro-Tek.** Barton, formerly a video support specialist with the company, will now serve Mycro-Tek as video sales consultant representing the Great Lakes region. In his new position Barton will coordinate direct sales and distributor sales efforts for the Mycro-Vision video display information system. Based in Chicago, his territory will include Michigan, Wisconsin, North and South Dakota, Nebraska, Iowa, Illinois, Ohio, Kentucky, Indiana, Missouri and Kansas. Contact: P.O. Box 47068, Wichita, Kan. 67201, (800) 835-2055 or (316) 945-5087.

RMT Engineering announced the addition of **David Chavez** as sales and marketing director. Chavez brings to RMT 12 years of experience in the cable TV industry. For the last three years Chavez has worked as national sales manager for Broadband Engineering. Contact: 625 E. Taylor Ave., Sunnyvale, Calif. 94086, (408) 733-4830.

Regency Cable Products has promoted **Arthur Leisey** to the position of senior field engineer. Leisey formerly served with Regency as a field service technician. Contact: 4 Adler Dr., East Syracuse, N.Y. 13057, (315) 437-4405.

Earth station receivers

R.L. Drake recently announced two products. The first is an enhanced version of the ESR 324 earth station receiver. The new ESR 324B block system model offers the convenience of a multiple receiver. Utilizing a 950-1,450 MHz IF output frequency, the new receiver is compatible with Drake's 85- and 100-degree LNBs or its BDC 24 block downconverter. A dual-polarity input adaptor is also available for automatic horizontal/vertical input switching in dual-feed installations.

R.L. Drake Co. also unveiled the ESR 424 earth station receiver. Available in single (ESR 424) or block (ESR 424B) conversion models, this receiver combines an assortment of features and a scaled-down design in one unit. Features include infrared remote control, audio seek tuning, fluorescent display and a redesigned weatherproof downconverter. In addition, the receiver provides descrambler compatibility through a bottom panel, clamped/unclamped video switch and microprocessor design.

The ESR 424B block system adds multichannel capability to the ESR 424 package. Utilizing a 950-1,450 MHz IF output frequency, the block conversion model features dual-input switching to eliminate the need for external relays or switching splitters. The ESR 424B is compatible with Drake's 85- to 100-degree LNBs or its BDC 24 block downconverter.

For further details, contact R.L. Drake Co., P.O. Box 112, Miamisburg, Ohio 45342, (513) 866-2421.

Mini-Hub and cables

Times Fiber Communications Inc. announced the addition of three new enhancements to its Mini-Hub II system product line. The first of these is a programmable remote control unit that enables a subscriber to program the Mini-Hub II in-home electronics and a VCR to record a maximum of eight events over a 14-day period. It is compatible with the basic remote-control unit, so both units can be integrated throughout the system.

A second product is a strand-mount enclosure, available in either an eight- or 16-unit size. These enclosures have been developed to allow the cable operator even greater flexibility for mounting Mini-Hub II's off-premises cable television equipment. They are lightweight, and durable, according to Times Fiber. Both enclosure sizes can be used with the different powering methods (60 VAC and drop power) that are available for the Mini-Hub II system.

The third addition to the product line is a drop powering method that enables the off-premises Mini-Hub II tuner to be supplied power from the power supply inside a subscriber's home.

Times Fiber also added two new products to its line of CATV cables. RG-611, a drop cable product, is a new size between RG-6 and RG-11 that provides the benefits of both cables without the disadvantages. The RG-611 drop cable has lower attenuation than RG-6, which allows longer cable runs and reduced system costs, according to Times Fiber. RG-611 uses standard feed-thru connectors. RG-611 drop cable is available in a variety of construction types including Quadshield, economy and standard coverage braid, single and single with lifeTime protectant, and flooded types.

The second new cable product is the TX Series of semiflex cable. This low-attenuation cable features a full-wall, seamless aluminum outer conductor with a high-velocity hard-foamed dielectric. TX cable is available in a wide variety of sizes and standard construction types.

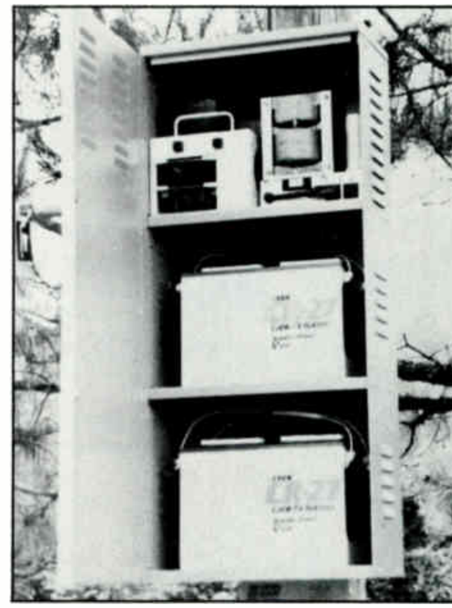
For more information, contact Times Fiber Communications, 358 Hall Ave., Wallingford, Conn. 06492, (203) 265-8500.

Lodging industry satellite package

Lodgenet, an entertainment and information concept, is now being offered to the lodging industry. The total package service provides a property with premium and basic satellite-delivered programming; local origination video information system capability; and an equipment package. Lodgenet was developed by program service distributor Satellite Movie Co. Inc., in cooperation with Blonder-Tongue Laboratories Inc., DX Communications Inc., and Miralite Corp.

Through Lodgenet, a lodging facility can purchase the basic satellite equipment required for interfacing with an existing MATV system. These include: a Miralite 3.7-meter TVRO satellite parabolic antenna with a tetrahedral polar mount for in-ground or rooftop mounting; a DX earth station receiver and downconverter that uses a discriminator circuit for signal demodulation, a full 30 MHz bandwidth, and a unique threshold extension circuit for low carrier-to-noise radio; an MAVM audio/video modulator from Blonder-Tongue that provides a modulated visual and aural RF carrier output on any single VHF, mid-band or super-band channel. It is used to put sound and color video on any unused channel of a closed-circuit MATV system. The MAVM features a heterodyne conversion system and a field-replaceable channel converter board.

For further information, contact Lodgenet, 108 N. Phillips Ave., Sioux Falls, S.D. 57102, (605) 338-1609 or (800) 257-2345.



Power supply

The Power Guard Division of Audioguard Inc. recently introduced its first generation standby power supply. Model SB-6012-24-0 features a modular design that allows the unit to be used as an add-on to existing non-standby power supplies; used as a replacement for other standby or non-standby power supplies; and purchased as a non-standby and upgraded to a fully operational standby power supply. Other features include: temperature-compensated battery charger; auto-switch when either module is removed; high-security housing locks; compact size; and surge protection.

For more information, contact Power Guard, P.O. Box 549, Hull, Ga. 30646, (404) 354-8129.

Video control switches

Qintar Inc. has announced a new line of video control switches to interface cable TV and videocassette recorders. Models 4004A, 4004B and 4005A allow a cable subscriber to record a pay station while watching a network station or vice versa. The switches were designed for easy customer use and to replace existing wiring that formerly involved three A/B switches and many cables. The switches include an extra auxilliary port for a game, computer, satellite dish or other RF device.

All three switches feature a minimum of 70 dB of isolation between all input and output ports. Passive switches also feature low insertion loss and 550 MHz bandwidth.

Amplified Model 4004A features 3 dB of gain after internal splitting losses are over-

SAFE! FAST! EFFICIENT!

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WIRE & CABLE

STAPLE GUN TACKERS

FIT RIGHT IN

for doing the CATV installation job RIGHT!

Rugged, reliable Arrow Wire & Cable Staple Gun Tackers are made of all-steel for lasting durability and engineered for safety, speed and efficiency with these built-in high performance features:

- **GROOVED GUIDE** positions wires and cables for proper staple envelopment and safe, secure fastening.
- **DRIVING BLADE** automatically stops at the right height to prevent staple from damaging or cutting into wire or cable.
- **AUTOMATIC, SINGLE-STROKE COMPRESSION ACTION** speeds up fastening, reduces installation time and minimizes hand fatigue.
- **PATENTED PRECISION-LOCKED MECHANISM** ensures smooth, uninterrupted trouble-free performance.

These outstanding features have made Arrow Wire & Cable Staple Gun Tackers the top choice in fastening tools of professional installation men in every field, including CATV, telephone, electrical, electronics, communications, alarm systems and many more.

4 Models Fit All Wires and Cables Ranging From 3/16" to 1/2" in Diameter.

MODEL T-18

Uses 3/16" round crown staples in 3/8" and 7/16" leg lengths - for diameters up to 3/16".

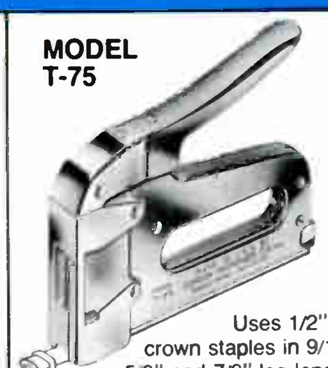
MODEL T-25

Uses 1/4" round crown staples in 9/32", 3/8", 7/16" and 9/16" leg lengths - for diameters up to 1/4".

MODEL T-37

Uses 5/16" round crown staples in 3/8", 1/2" and 9/16" leg lengths - for diameters up to 5/16".

MODEL T-75



Uses 1/2" flat crown staples in 9/16", 5/8" and 7/8" leg lengths - for diameters up to 1/2".

THE RIGHT ARROW TACKER AND STAPLE SIZE TO USE FOR THE RIGHT CATV INSTALLATION:

For fastening ground wire - use Model T-18 with 3/8" leg staple.	For fastening RG-59 - use Model T-25 with 9/16" leg staple.	For fastening RG-6 - use Model T-37 with 9/16" leg staple.	For fastening RG-11 - use Model T-75 with 5/8" and 7/8" leg staples.

Call your supplier or write for catalog & prices.

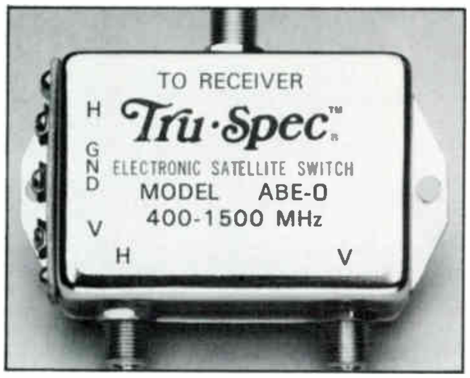
ARROW FASTENER COMPANY, INC.

271 Mayhill Street
Saddle Brook
New Jersey 07662

Reader Service Number 57.

come, a low noise figure, and a U/L approved power pack. Qintar's newest amplified model, the 4005A, contains a high-power transistor allowing 54 channels of operation with cross-modulation below −60 dB.

For more information, contact Qintar, P.O. Box 6579, Westlake Village, Calif. 91359, (800) 252-7889; on the East Coast, call (800) 233-2147; in Pennsylvania, (800) 482-2398.



Satellite V/H switch

Macom Industries/OEM Sales announced the addition of two new electronic V/H switches to its satellite accessory line. The Model ABE-D and ABE-M are solid-state pin diode switches that provide a minimum of 35 dB isolation (in the worse case 1,450 MHz minimum) with a low insertion loss of 3 dB, according to the company. DC switch control is provided through screw terminals. The two models were developed with slightly different DC control input requirements to accommodate all receivers on the market with a DC V/H switch output.

For more details, contact Macom Industries/OEM Sales, 8230 Haskell Ave., Van Nuys, Calif. 91406, (818) 786-1335 or (800) 421-6511.

Receiver, LNC system

Microdyne's 1100 HDR satellite video receiver and low-noise converter system offers flexible access to any satellite format available, according to the firm. The 1100 HDR receiver is designed for use with the new high-performance and low-cost converters that are now available. With a 750 MHz input band, the 1100 HDR provides access to the full range of international satellite broadcasts.

The 1100 HDR receiver provides front panel selection of up to 96 channels, 48 of which are factory-set and 48 customer-specified. It can be purchased with optional dual IF filters for half and full transponder operation, and dual audio demodulators. Both low-noise converters for C- and Ku-band have an output in the 950 MHz to 1450 MHz range.

For more information, contact Microdyne Corp., P.O. Box 7213, Ocala, Fla. 32672, (904) 687-4633.

Computerized test system

The RF/Superior division of R.F. Analysts announced the CAT I, an automatic computer-aided test system designed to measure both frequencies and levels of all signals on a cable system. The measurements can be observed locally at the headend or can be remoted to a central office using an RS232 port and modems. As many as 15 sites can be maintained from a master control center.

With the CAT I, there are several measurement features to choose from: headend temperature, system bandpass, inter-carrier frequencies, slope, day-to-day variation, and prediction of out of tolerance points on both frequencies and self determined amplitude.

The CAT I works in four basic modes to define this data: amplitude measurement only; frequency measurement only; amplitude and frequency measurements combined; and trends (using stored data).

For additional information contact R.F. Analysts, 112 E. Ellen St., Fenton, Mich. 48430, (313) 750-9341.

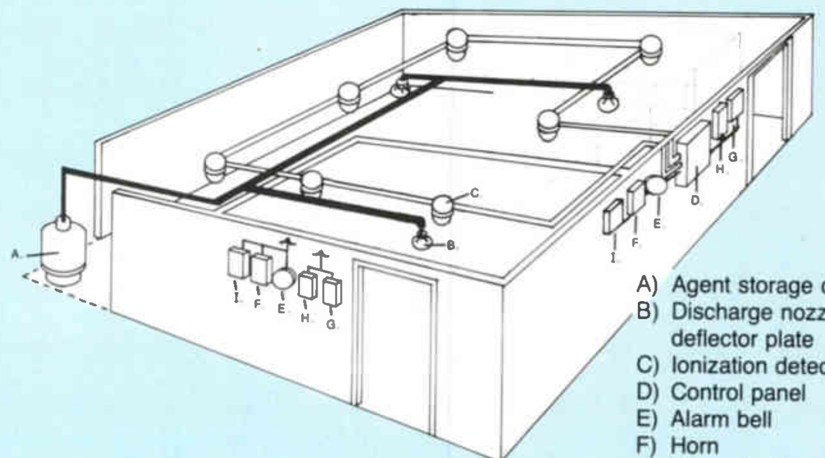
Headend protection from possible fire loss

By Bob Gibbs
National Sales and Marketing Manager
FiQuench Division, Fike Metal Products Corp.

With the growing consumer popularity in cable television, many new cable systems are being established and older ones updated to meet the ever increasing demand. Choosing adequate fire protection for expensive electrical equipment such as microwave processors, switching networks, signal processors and other devices located in a headend facility requires special consideration. Leaving this responsibility to "ordinary" means of fire protection (hand-held portable extinguishers and/or an automatic sprinkler system) can be a costly mistake.

The hand-held portable extinguisher relies on human response and, many times, even a small fire in a complex electrical system can be virtually inaccessible. An automatic sprinkler system provides excellent back-up protection but due to its fixed-temperature fusible elements a major heat source must exist in order to actuate the system. By this time serious and costly damage can occur from both the heat source and quantity of water required to extinguish the fire. To reduce the risks of personal injury, costly downtime and substantial equipment damage, an automatic fire suppression system (that can rapidly detect and extinguish a fire without leaving equipment damaging residue or creating a life safety hazard) should be considered.

Figure 1: Typical Halon 1301 fire suppression system



Halon 1301: Bromotrifluoromethane

The state-of-the-art fire suppression system for a headend facility utilizes an extinguishing agent known as Halon 1301 (bromotrifluoromethane). When one understands the characteristics of Halon 1301, its advantages over the standard fire extinguishing agents (water, carbon dioxide or dry chemicals) become apparent. Halon 1301 is odorless, colorless, electrically non-conductive, non-corrosive, and leaves no residue when it is discharged. However, Halon 1301's major advantage is the fact that it can be released with people present without causing any harm to the personnel in the protected area.

The personnel safety factor has been tested extensively by hospitals, independent research organizations and general industry. Because Halon 1301 is colorless, people located within the protected area as the system discharges would not have to worry about vision obscuration, as would be the case with other common extinguishing agents such as dry chemical or carbon dioxide. Halon 1301 is electrically non-conductive so it is especially appropriate for use in areas such as headends and other facilities where people and expensive electrical equipment are present. Halon 1301 is discharged as a gaseous vapor, so it can rapidly penetrate throughout an electrical enclosure and around all wires to get to the source of the fire itself. Halon 1301 also is safe for use around sensitive electronic equipment and other such items where the corrosion caused by water, dry chemical or other extinguishing agents would pose an extreme problem.

In a fire extinguishing system (Figure 1), Halon 1301 is stored as a liquid in one or more storage containers. When called upon by the control panel, the chemical will flow through whatever piping is required and will immediately flash from a liquid to a vapor as it is released through the discharge nozzles. These discharge nozzles are specially designed and tested to give a specific dispersal pattern and provide for the uniform mixing of the Halon 1301 within the protected area. Because the Halon 1301 and air mixture is approximately five times heavier than normal air, it will actually displace pockets of unprotected volume and force the "lighter" ambient air to rise out of closed cabinets or other such enclosures.

The final analysis

The cost for a complete Halon 1301 system including detection and control for a typical 30′ x 30′ x 10′ headend facility should be somewhere in the neighborhood of $7,000 installed. Considering equipment replacement costs and possible downtime losses that would be incurred in the event of a fire, this is a relatively small cash outlay to protect such a large investment.

Remember when 20, 12-even 5 channels were your maximum potential? Now...

Rebuilding? Save Money With JERROLD

Remember, back in 1951, when TV stations were low in power and antennas not very efficient? Milton Jerrold Shapp, the founder of Jerrold, didn't realize he was helping to create a new industry when he developed an amplifier that Bob Tarlton needed for his Lansford, PA community antenna system.

Cable was new, but it grew rapidly. And Jerrold grew with it, developing improved amplifiers, channel equipment, and numerous innovations that increased revenue potentials for operators, and established Jerrold as the leading supplier in the industry.

Expand the bandwidth of your system - and your revenue-producing channel potential - simply by dropping in Jerrold STARLINE® SJ-330 modules. This quick and easy upgrade to 330 MHz can help you maximize your revenues and requires:

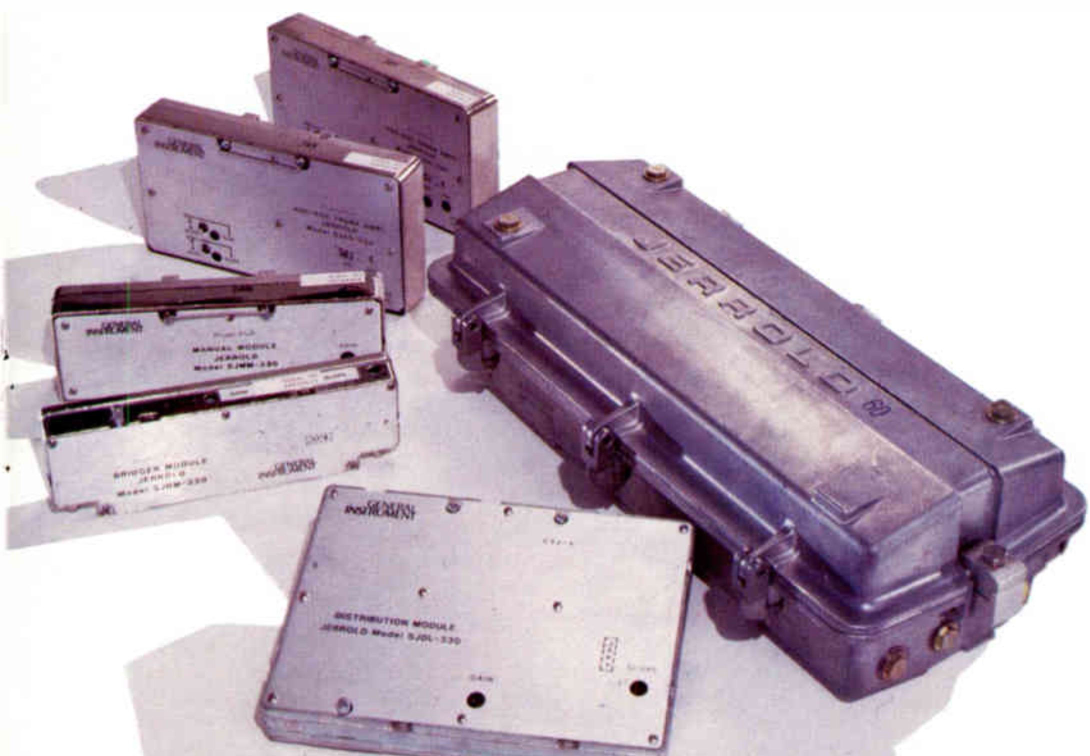
- No respacing of trunk amplifiers
- No major equipment costs
- No prolonged construction

Regardless of the make or vintage amplifiers now in your system, Jerrold can show you how to rebuild economically. If you have STARLINE 20 equipment, you'll realize the biggest savings with Jerrold STARLINE SJ-330 drop-ins. Other amplifiers can be replaced easily and economically by a complete STARLINE SJ-330 station. Detailed information on what you will need and what savings you can achieve is contained in a new Jerrold STARLINE 20 SJ Series brochure - yours for the asking.

And Jerrold has other possibilities for you too. For longer cascades and greater channel capacity, there's Jerrold Century III Feedforward amplifiers and the Jerrold STARLINE X Series. Whatever your specific needs, there's a reliable, low-cost Jerrold product to satisfy them.

Send for the Jerrold STARLINE 20 SJ Series brochure, today. Call or write: Jerrold Division, General Instrument Corporation, 2200 Byberry Road, Hatboro, PA 19040. (215) 674-4800.

JERROLD
You know we'll be there.



See us at the Atlantic Show at Booth 533.

Reader Service Number 60.

GENERAL INSTRUMENT

CALENDAR

September

Sept. 4: SCTE Hudson Valley Meeting Group seminar, Holiday Inn, Fishkill, N.Y. Contact Robert Price, (518) 382-8000, or Andy Healy, (914) 561-7880.

Sept. 5: SCTE Florida Meeting Group seminar on lightning and distortion, Quality RF, Jupiter, Fla. Contact Richard Kirn, (813) 924-8541.

Sept. 9-10: Wisconsin Cable Communications Association's meeting at the Concourse Hotel, Madison, Wis. Contact Lynn Walrath or Cheryl Cuccia, (608) 256-1683.

Sept. 9-11: Tennessee Cable Television Association annual meeting, Hyatt Regency Hotel, Nashville, Tenn. Contact Dan Walters, (615) 256-7037.

Sept. 9-13: M/A-COM MAC training seminar, MAC training and conference center, Burlington, Mass. Contact Carolyn Calorio, (617) 272-3100.

Sept. 10-11: Society of Cable Television Engineers and **SCTE Rocky Mountain Meeting Group** technical seminar on signal leakage, CLI and the FCC, Denver. Contact Sally Kinsman, (303) 696-0380.

Sept. 10-12: Jerrold technical seminar, Boston. Contact Beth Schaefer, (215) 674-4800.

Sept. 10-12: Texscan Instruments training program, Indianapolis. Contact Ron Adamson or Brenda Gentry, (317) 545-4196.

Sept. 11-13: Magnavox CATV training seminar, Worcester, Mass. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

Sept. 15-17: South Dakota Cable Television Association annual meeting, Sylvan Lake Resort, Custer, S.D. Contact (605) 854-9121.

Sept. 16-18: Magnavox CATV training seminar, Worcester Mass. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

Sept. 17: Pennsylvania Cable Television Association annual meeting, Atlantic City, N.J. Contact Patricia Wilson, (717) 234-2190.

Sept. 17-19: C-COR Electronics technical seminar, Toronto. Contact Deb Cree, (814) 238-2461.

Sept. 18-20: Atlantic Cable Show, Atlantic City, N.J. Contact (609) 848-1000.

Sept. 25: SCTE Appalachia Mid-Atlantic Chapter business meeting, Holiday Inn, Chambersburg, Pa. Contact Flint Firestone, (301) 252-1012.

Sept. 25-27: Illinois, Indiana, Ohio and Michigan CATV Associations present the Great Lakes Expo, Convention Center, Indianapolis. Contact the Ohio Cable Television Association, (614) 461-4014, or (517) 351-5800.

Sept. 25-28: Hawaii Cable Television Association's third annual convention, Coco Palms Resort Hotel, Kauai, Hawaii. Contact Kit Beuret, (808) 834-4159.

Sept. 30-Oct. 2: Ontario Cable Television Association's eighth annual convention, Toronto. Contact (416) 481-4446.

October

Oct. 1-3: International Construction & Utility Equipment Exposition, "ICUEE/85," Fairfax Airport, Kansas City, Kan. Contact (312) 236- 6470.

Oct. 2-3: Online Conferences Ltd. system security conference, London. Contact 01-868 4466.

Oct. 2-4: Magnavox CATV training seminar, Atlantic City, N.J. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

Oct. 7-9: Magnavox CATV training seminar, Atlantic City, N.J. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

Oct. 8-10: Jerrold technical seminar, Pittsburgh. Contact Beth Schaefer, (215) 674-4800.

Oct. 11-13: Satellite Today's Eastern home electronics satellite dish/video expo, Orange County Convention Center, Orlando, Fla. Contact Bonnie Mundie or Dee Botsford, (602) 581-0188.

Oct. 14-17: Building Industry Consulting Service International's fourth annual "Telecom West" conference and exposition, Sheraton Scottsdale Resort, Scottsdale, Ariz. Contact Joe Greenberg, (602) 965-1740.

Oct. 15-17: Texscan Instruments training program, Indianapolis. Contact Ron Adamson or Brenda Gentry, (317) 545-4196.

Oct. 16: SCTE Delaware Valley Chapter meeting on technical management, Willow Grove, Pa. Contact Beverly Zane, (215) 674-4800.

Oct. 22-24: C-COR Electronics technical seminar, Montreal. Contact Debra Cree, (814) 238-2461.

Oct. 22-25: International Council for Planning and Innovation's "WorldCom 85," Hyatt Regency Hotel, San Francisco. Contact (703) 437-0027.

Oct. 28: Waters Information Services conference on "Profit Opportunities in Data Broadcasting," Westin St. Francis Hotel, San Francisco. Contact Merrill Oliver, (607) 770-1945.

Oct. 29-31: Online Conferences international meeting on videotex, RAI Centre, Amsterdam. Contact Online, (212) 279-8890.

November

Nov. 4-6: National Cable Television Association's fourth annual minority business symposium, Sheraton-DTC, Denver. Contact Sylvia Marshall, (202) 775-3690.

Nov. 6-8: Magnavox CATV training seminar, Greensboro, N.C. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

Nov. 11-13: Magnavox CATV training seminar, Greensboro, N.C. Contact Laurie Mancini, (800) 448-5171; in New York, (800) 522-7464.

Nov. 11-15: M/A-COM MAC training seminar, Burlington, Mass. Contact Carolyn Calorio, (617) 272-3100.

Nov. 12-14: Jerrold technical seminar, Atlanta. Contact Beth Schaefer, (215) 674-4800.

Planning ahead

Dec. 4-6: Western Show, Convention Center, Anaheim, Calif.

March 15-18: National Cable Television Association annual convention, Dallas.

June 12-15: Cable-Tec Expo '86, Phoenix (Ariz.) Convention Center.

AD INDEX

Opening Pandora's box?

By Robert A. Luff
Senior Vice President, Engineering
United Artists Cablesystems Corp.

With CATV publications, industry seminars and the National Cable Television Association itself chanting the need for immediate scrambling of all satellite programming to stop our backyard freeloaders from destroying the CATV industry, how can anyone be against satellite scrambling?

Arguments for

There is an astounding growth of backyard dishes. Recently released research findings indicate that there may be over 1.5 million installed backyard dishes receiving satellite programming intended for CATV headends. The report stated that new backyard dishes are being installed at the rate of 55,000 per month. And, that perhaps as many as 30 percent of these new dishes are being installed in locations passed by cable. According to SPACE, the association for backyard dish owners, the ultimate market is between 22 million to over 40 million homes in a true Ku-band DBS technology. It is interesting to note that there are an estimated 22 million U.S. homes not currently in or expected to be in a CATV franchise area. Therefore, the rest of SPACE's total estimate must come from the cable industry's homes passed!

No one is against scrambling. Despite what our industry may be feeding you to the contrary, even SPACE freely supports a fair system for backyard dish owners to pay their fair share. SPACE simply wants the free market system, not a monopolistic single entity, to establish the ultimate technical scrambling technology or technologies to be used with various, competitive revenue collection schemes.

So if everyone wants satellite scrambling, why doesn't the CATV industry organize an independent cooperative to pick a satellite scrambling technology and develop a billing and revenue collection system? Not so fast!

Arguments against

Although there are no arguments against satellite scrambling per se, there are many overwhelming arguments against an emotionally fired innercircle of industry leaders short-circuiting the natural marketplace and forcing their handpicked satellite scrambling technology and their particular revenue collection scheme on both backyard dish owners and the cable industry alike. We are to be told that the end justifies the means. Immediate scrambling of all satellite programming (whether the programmer thinks so or not) is imperative, and that to open the issue to more formal processes and debate would simply take too long.

Well, I am in fundamental disagreement with such a philosophy. None of us are as smart as all of us together.

The concept of a single or universal satellite scrambling technology is very shortsighted and extremely dangerous to the long-term best interest of the cable industry because it limits our selection to questionable satellite scrambling choices and restricts future R&D for better systems. A quick decision to use a technology that can be almost immediately put into place limits the choice to only one or two scrambling schemes, which even their own developers admit have several shortcomings if applied to both CATV headends and backyard dish environments.

It also should be noted that the leading contender for the ill-fated nod to protect and carry the cable industry's backbone signals for the next decade or so is based on the antiquated NTSC television transmission format, which was adopted in 1942! Certainly, with stereo, aspect radio changes, and higher-resolution pictures just around the corner, and with VCRs, DBS and MMDS nipping at our heels, the cable industry should think twice about entering our new competitive era with our bandwagon hitched to an already 43-year-old horse.

Further, regardless of how secure a scrambling technology may seem, it would be foolhardy for the cable industry to expect that a national scrambling technique would not be compromised within a year or two of implementation. The rewards would just be too great by too may sectors for single scheme to not be broken and circuit boards available for a fraction of the total ticket price.

And lastly, our competitors over the past decade—MMDS, STV, and DBS—failed because of limited channel capacity and inadequate scrambling and revenue collection technology. The FCC's continued deregulation is solving their channel capacity problems—note that some MMDSs have up to 25 channels! If our industry leaders force a premature de facto scrambling national standard, especially one that was designed primarily as a set-top unit not a headend rack-mount unit (think about it), would not these units be equally available to our adversaries for the same terms and warranties? Wouldn't we be solving our competitors' remaining security and collection obstacles? By forcing a premature de facto satellite standard to address what may ever only be a 1 or 2 percent backyard dish problem, we may be opening Pandora's box for much more assertive competition from far more worrisome opponents.

Addressing TVRO growth

Instead of acting like a monopoly and trying to control our competition, cable should address itself to the underlying reasons for home TVRO growth. Why are there so many backyard dishes? It is obvious that cable is not meeting the needs of millions of TV viewers. We know already that the CATV industry has chosen not to pass some 20 million homes because of uneconomical density. Perhaps we should have focused as an industry on developing rural CATV technology alternatives—for it is the vitality of this large sector that has driven the backyard dish industry into our backyard.

But what about the 30 percent of new dishes being installed in cable franchise areas? I called SPACE for their explanation, and believe it or not, the answer was that dish owners *want more choice*. More, or at least a different choice in what the cable operator decides to carry was the number one reason. Higher technical picture quality and stereo sound rated an honorable mention. Avoiding monthly cable bills did not even make the list.

Suspicious, I undertook my own survey of homes in my area sitting under trunk and feeder and confirmed the same answers. Many mentioned the lure of personally participating in space-age technology as one of the reasons for purchasing their dish. Interest in sports teams not regularly carried by the local cable programming but available on the bird was one of the major "final" reasons for purchasing a dish. No one felt, or at least didn't mention, that the dish was cheaper than cable.

There seems to be a message for the cable industry to get back-to-basics, providing more programming choice to our current and potential subscribers. With the latest distribution and addressable technology, is there really any excuse for the cable industry that pioneered choice and satellite technology to not provide the most programming for the most reasonable fee?

More choice, reasonable rates

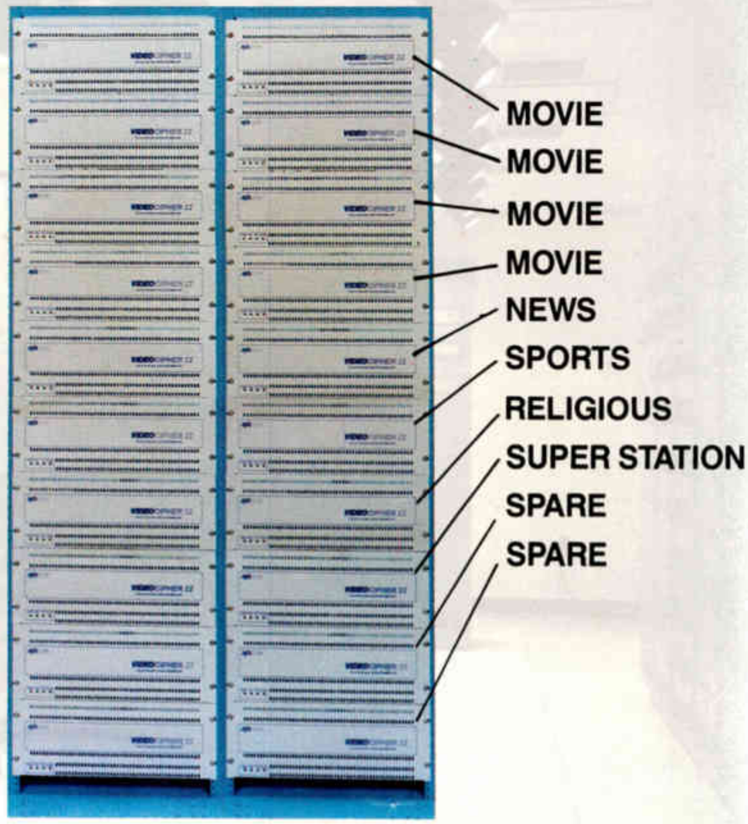
The cable industry has misfocused the backyard dish problem. As a result, its obsession to scramble satellite signals at all costs is misdirected. The issue with backyard dishes is choice, not theft-of-service. The cable industry must understand that the underlying force driving the backyard TVRO market is that homeowners want more choice of programming and are not simply trying to get something for nothing. While satellite scrambling may very well be in order to indeed collect everyone's fair share, satellite scrambling is not going to stop the backyard TVRO growth. Only more cable choice at reasonable rates can do that in a competitive environment.

The large satellite programmers, MSOs and cable trade associations cannot continue to operate like we are a monopoly. Whether we like it or not, the FCC has created an environment of open competition. Those that move quickly to develop what the public wants—programming choice and reasonable rates—will succeed.

It's Cable TV's Great New Revenue Producer!

VIDEOCIPHER® II

M/A COM'S ADDRESSABLE DESCRAMBLER NOW STOCKED BY ANIXTER®



M/A COM's VideoCipher II, the revolutionary descrambler, accepted for use in demanding high quality broadcasting environments, is now available through Anixter's nationwide distribution network.

This new system produces a descrambled signal that is indistinguishable from the original, even at low C/N.

VideoCipher II descramblers are rack-mounted and interface easily to commercial satellite receivers.

VideoCipher II can control up to 56 independent tiers of programming, and its security system assures that a descrambler can only receive programming in tiers for which it has been authorized.

And, when planning to order your **VideoCipher II** descramblers, remember it's good business practice to have a couple of spare descramblers to serve as common back-ups.

VideoCipher II descramblers are backed by M/A COM's exclusive warranty plus the M/A COM 24-hour, 7-days-a-week service.

Call the Anixter location in your area to order your **VideoCipher II** descramblers or for additional technical information.

ANIXTER® COMMUNICATIONS

CORPORATE OFFICES, ANIXTER BROS., INC., 4711 Golf Road, Skokie, IL 60076, (312) 677-2600

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Reader Service Number 63.